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ABSTRACT

This is one of several teacher's guides for the 4M Company, a set of materials for teaching metric concepts and computation skills to elementary school students. Included in this guide are sections on needed materials, length (ancient Hawaiian units, meter decimeter, centimeter, addition, subtraction), decimals related to meters (measurement, addition, subtraction), capacity (liter, deciliter) decimals related to liters (addition, subtraction), mass (gram, kilogram, addition, subtraction), perimeter, temperature, and a minicourse on metrics. Answers to the activities in the related student activity manual are included. (RH)

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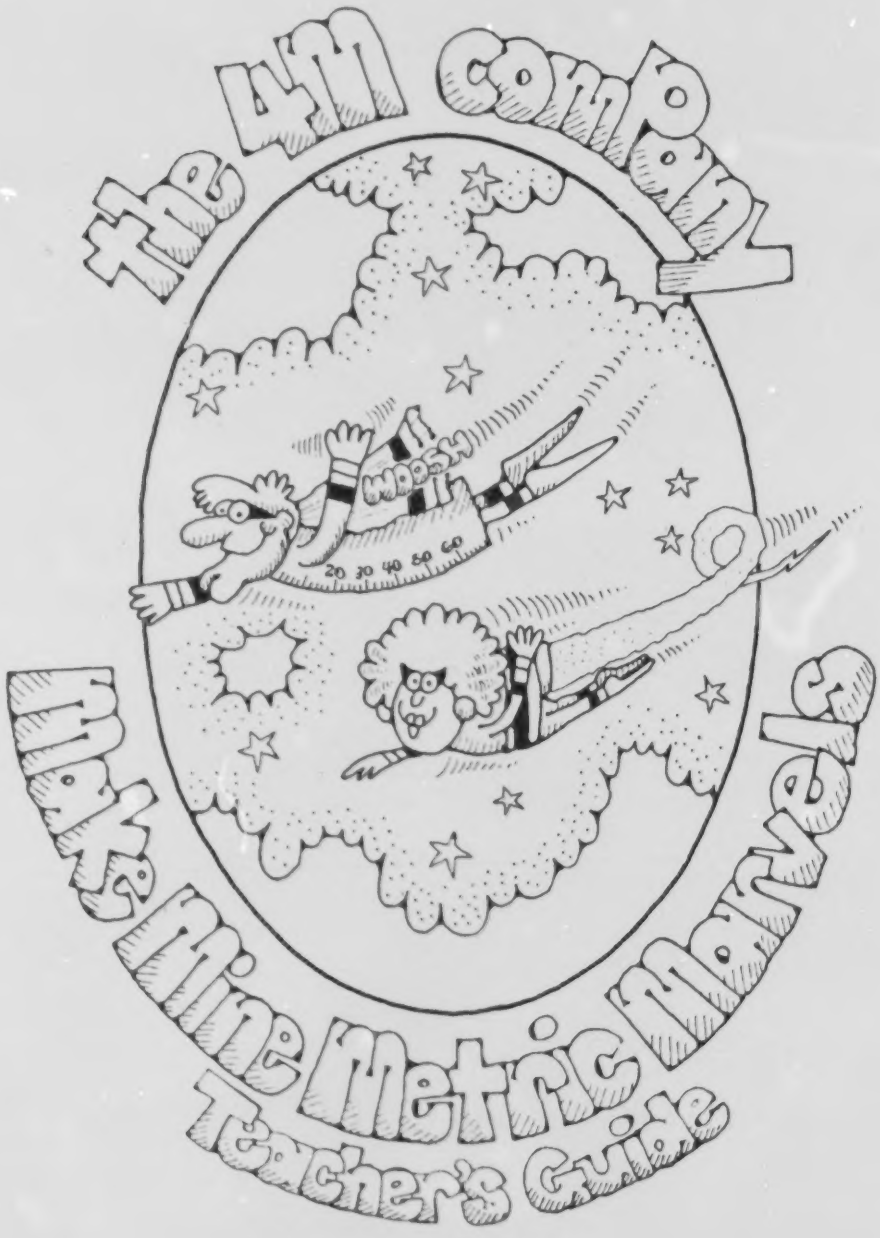

presents

the metric system

starring the

MAKE MINE METRIC MARVELS

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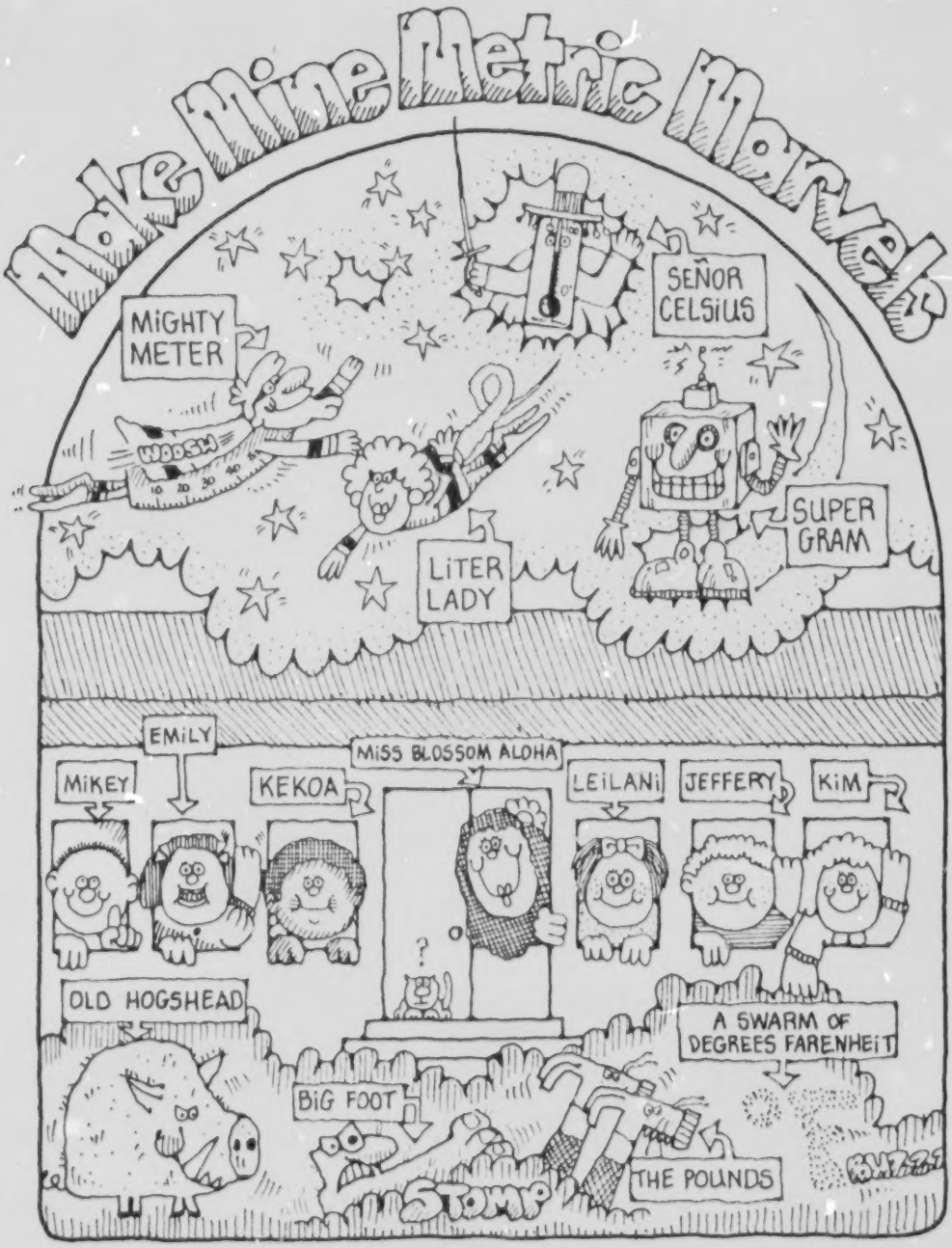
Make mine Metric Marvels
MIGHTY METER
SEÑOR CELSIUS
SUPER GRAM
LITER LADY
EMILY
MIKEY
KEKOA
MISS BLOSSOM ALOHA
LEILANI
JEFFERY
KIM
OLD HOGSHEAD
BIG FOOT
STOMP
A SWARM OF DEGREES FAHRENHEIT
THE POUNDS

Miss Blossom Aloha is trying to teach her students about the metric system. But she is continually interrupted by some old-fashioned units of measurement: Big Foot, Old Hogshead, the Pounds, and a swarm of degrees Farenheit.

Little Kekoa, one of Miss Aloha's students, has some very special friends: **Mighty Meter, Liter Lady, Super Gram, and Senor Celsius.** By pressing the correct buttons on his magic wrist transceiver, the Make Mine Metric Marvels arrive and fight for truth, justice, and the AMETRICAN way of life!

the 4M company

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to the teacher... read carefully before you begin teaching

Curriculum materials are only one of the factors involved in the learning process. No program can anticipate the other factors - your unique characteristics as a teacher, the characteristics of your students, and your classroom situation. Yet these factors must all be considered for a successful learning experience. It is you, the teacher, who must analyze these factors to make decisions and adjustments in the learning activities as described in this Teacher's Guide.

The 4M COMPANY provides a variety of classroom organizations: at times students will work as an entire class, at times they will work in small groups, and at times they will work alone. Depending on the unique combination of factors which make up your classroom, the procedures recommended in this Teacher's Guide may or may not work in your particular classroom. Feel free to adapt the program to meet your particular needs. Following the Teacher's Guide word-for-word is not important; learning the objectives of the program is.

You are a unique person, and no one will teach the 4M COMPANY exactly as you do. Your strengths, your weaknesses, your abilities, and your overall philosophy will influence your teaching. Keep in mind, however, the following roles which you must play as a teacher.

The role of a planner. The 4M COMPANY is an activity program, and you will be required to prepare materials for most lessons. Things will not always work out as you had planned, so be prepared to alter your plans if the need arises.

The role of a demonstrator. Although this Teacher's Guide outlines one approach to teaching the objectives of a lesson, you must decide if a given demonstration is working with your students. They are unique, and you may have to alter the demonstration to meet their level of understanding.

The role of a questioner. Instead of always giving answers, ask the children remedial questions that will clarify their thinking. Ask more difficult questions of children who need more challenge.

The role of a motivator. No student can be made to learn if he doesn't want to. The 4M COMPANY has tried to motivate children in several ways - the cartoon format of the booklets, the use of a story line for each grade level, and the use of games and activities. But in addition to our efforts, you will still need to motivate and encourage children to learn.

The role of summarizer. At the conclusion of each activity, you encourage students to share their findings. It is important to summarize the results of each activity.

We have tried to make The 4M COMPANY an enjoyable and effective metric program. To a large extent your attitude will determine the success of the program. If you are unfamiliar with parts of the metric system, admit this to yourself and to your students. If you adopt a positive attitude of learning with your students, this will do much to create a good classroom environment. For ready reference, the Appendix of this Guide contains a brief review of the metric system.

The following paragraphs deal specifically with this level of The 4M COMPANY.

content

At this level students are exposed to the following metric units: meter, decimeter, centimeter, liter, deciliter, centiliter, gram, kilogram, decigram, centigram, and degree Celsius. Decimeters are represented as tenths of a meter, and students measure and compute with one-place decimals. Exposure to the chart of metric units helps introduce the structure of the metric system.

management

Management will be a key factor in the success of this program. Seatwork that reinforces metric concepts of vocabulary has been included in key places in the program to help alleviate the classroom management problems that accompany activities. Many children enjoy coloring in their metric booklets. This can serve as an aid in classroom management. While you work with a small group, others can color in their books. However, no child should be forced to color, and care should be taken not to compare or judge the quality of the coloring.

decimals

In metrics, the base ten nature of the metric system is used to introduce decimal fractions as a natural part of measure. A decimeter is 0.1 meter and a deciliter is 0.1 liter. The emphasis is upon how to measure, read and write decimal expressions. A complete understanding of place value is not expected at this level. Such an understanding will develop through several years of repeated exposure to and practice with decimal notation. The goal of The 4M COMPANY is to generalize the idea of a decimal fraction in the last level of the program.

zero

In writing decimal expressions less than 1.0, it is now recommended that a zero be placed in the one's place. For example, 0.3 meters is recommended instead of .3 meters. This convention is practiced worldwide. The use of the zero has two main advantages. 1) If the decimal point is light, or somehow erased, it is immediately evident that the point is missing. For example, 03 means three tenths, or 0.3. Three one hundredths would need two zeros, 0.03. Thus, if we see 003 we know it is probably 0.03. 2) In teaching small children it helps us distinguish the fractional parts from the whole parts. For example, in the expression .27, some children might think that the 7 is in the one's place and the 2 in the ten's place. By placing a zero in the one's place this confusion might be avoided.

estimating

Throughout the program children should be encouraged to estimate before measuring. Encourage careful measuring, but explain that no measure is exact. Use the words "about" or "almost" to describe inexact measurements. This is the initial step in understanding how to round off to the nearest whole unit.

reinforcement

Experience has shown that retention of metric concepts and vocabulary will occur only if they are reinforced throughout the school year. Make a flashcard for each metric unit and another for its symbol. Use these

frequently to reinforce metric vocabulary. It is also a good idea to set metric units in front of the class and have them identify the various units by name. Familiarity with the units is a major goal of the program, and this can be achieved by frequent drill and review.

computation

In The 4M comPany addition and subtraction appear as applications of measurement. It is expected that these concepts will be taught in the regular math program. The work in The 4M comPany will reinforce these concepts and skills. Because we do not want the lack of computational skill to interfere with a student's success in measurement, the addition and subtraction problems may appear to be somewhat easy for better students.

rounding off

Measurement provides an easy, visual model for teaching students how to round off: the measurement is rounded off to the nearest unit by merely looking at the measuring instrument. It is not until later that students will be taught how to round off written expressions. At this time rounding should be kept at an informal, concrete level.

metric chart

It is recommended that each classroom have a chart of the metric system. Put one up early in the year and as each metric unit is introduced, point it out on the chart. Page 83 in this Teacher's Guide may be used to make a colorful poster where each unit can be highlighted with color when it is introduced. The page may be removed, used to make an overhead transparency, and the overhead projector used to enlarge the chart onto a piece of poster board where it can be traced and colored. An opaque projector may be used to accomplish the same thing using the page directly.

spelling

At the time of printing there was no national policy on the spelling of the words "meter" and "liter." Some groups are advocating "metre" and "litre." We have gone with the "er" spellings. However, it is a good idea to expose students to both spellings. They will see both, and both are correct.

section number	materials description
1	none
2	demonstration meter stick, adding machine tape cut in 1 meter lengths
3	ten decimeter blocks or strips (see back of manual), meter stick, adding machine tape one meter long (student's meters from Section 2), scissors
4	meter stick, dm strip, several cm units (blocks or pieces of paper 1 cm long), centimeter rulers for students
5	adding machine tape, meter stick, dm ruler, cm ruler
6	adding machine tape, dm ruler
7	adding machine tape, decimeter strips
8	meter marked in tenths, decimeter strips, thumb tacks, adding machine tape
9	decimeter strips, number line marked in tenths of a meter
10	decimeter strips, number line marked in tenths of a meter
11	liter measure, empty half gallon milk carton, bucket, gallon jug, and a variety of containers (cup, glass, soda can, 8 oz. milk carton)
12	deciliter measure, liter measure, 5 oz. milk carton, a variety of other containers, a centiliter measure (if available)
13	deciliter containers (3-1/2 oz. Solo cups are just the right size)
14	deciliter containers (3-1/2 oz. Solo cups)
15	2 identical empty half gallon milk cartons, plastic gram weights (one per student), balance, pencil, several small objects to weigh on the balance, several cans of food (at least one marked in grams)

section number	materials description
16	meter stick, decimeter strip, liter container, deciliter container, balance, 1-gram weight
17	kilogram weight, metric bathroom scale
18	metric bathroom scale
19	cm measuring tapes, meter stick marked in centimeters
[illegible]	Celsius thermometers, several glasses, ice cubes, a jar or thermos of hot or warm water

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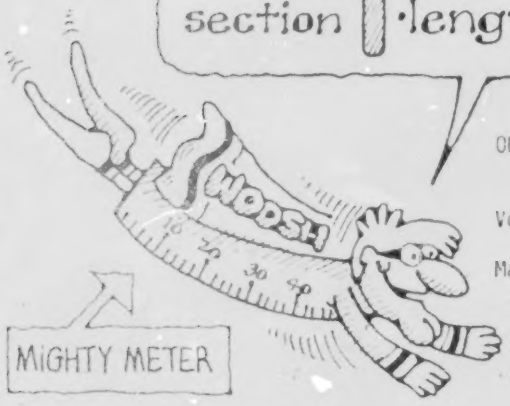
section 1 · length: ancient Hawaiian units



Objectives: Given an ancient Hawaiian unit of length, determine the length of an object.

Vocabulary: anana, muku, iwilei

Materials: none

NOTE: Students are not required to memorize these units.

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Ask the class, "If you didn't have any rulers, what could you use to measure the length of this room?" Parts of the body might be suggested. Demonstrate the three ancient Hawaiian measures to the class. Anana is finger tip to finger tip, muku is elbow of one arm to finger tip of the other; iwilei is finger tip to nose.

2. Select a large and small child. Compare their "ananas," then have each measure a long distance (such as the length of a wall) in ananas. Since they have different sized ananas, the measurements should differ. Discuss.

3. Then let each child complete page 1. They are to measure the classroom with each of the three Hawaiian units. To avoid confusion have the students work in small groups wile others are doing seatwork. Children should round off to the nearest whole unit. "The wall is about ten ananas long." You may need to demonstrate how to do this.

4. Discuss why the measurements are different, why it takes fewer ananas than iwileis, etc.

5. Homework. Ask the children to measure the lengths of their bedrooms in ananas.

MEASURE FROM OLD HAWAII

Our classroom is about _____ananas long.

Our classroom is about _____muku long.

Our classroom is about _____wileis long.

ANSWERS

My bedroom is about _____ananas long.

1

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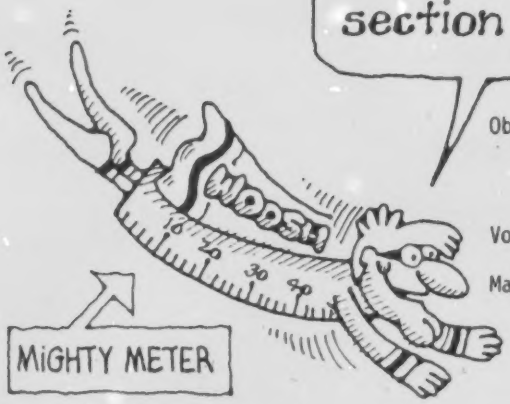
section 2 · length: meter



Objectives: Given a meter stick, determine the length of an object to the nearest meter.

Spell "meter".

Vocabulary: meter, m

Materials: demonstration meter stick, adding machine tape cut in 1 meter lengths

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Since everyone has a different anana, discuss the need for a standard measure which never varies. Introduce the meter. The meter is the base unit of length in the Metric System. It is used by people all over the world. Give each student a meter strip cut from the adding machine tape. Have him write his name on the strip; he can fold it up and keep it in his math book. He will need it for Section 3. Introduce the symbol for meter, a lower case m. Write the word and its symbol on the board. Have children spell it in unison with their eyes closed.

2. Hold up a meter stick and have students come forward one by one to compare their ananas (full arm span) to the meter. The meter should be shorter than the anana. Have each child place one hand at each end of the meter stick, then step away to show with his hands how long a meter is. The purpose is to give the students a better idea of the length of a meter. From time to time ask the class to hold their hands apart to show a meter. Check several children's hands with a meter stick to see how close they are.

3. From time to time hold up a meter stick and ask students, "How long is this?"

4. Demonstrate three ways to measure with meters to find the length of the room:

   a) Place paper meter strips end to end across the room. If a strip starts to curl, turn it over. Make sure there are no gaps between strips and that they do not overlap. Count the number of meter strips together as a class and write the measure on the board. If the measure is not exact, show how to round off to the nearest meter.

   b) Use two meter sticks in leap-frog fashion. Lay two meter sticks end to end, then pick up the first and place it at the other end of the second one, etc. Keep count of the meters as you cross the room.

   c) Use only one meter stick. Place the meter against the wall, hold one finger at its end, move the meter stick so that its other end is at your finger, etc.

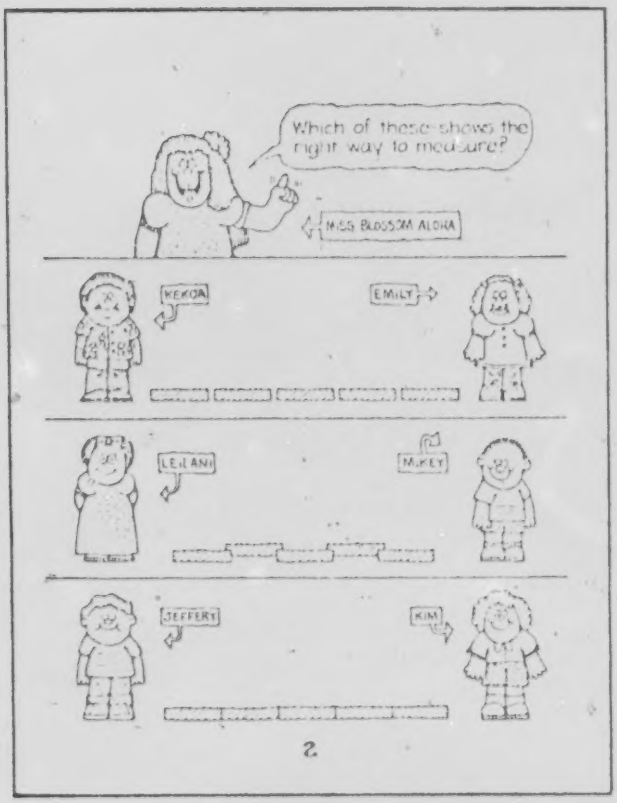
   Emphasize that care must be taken when we measure in any of these three ways.

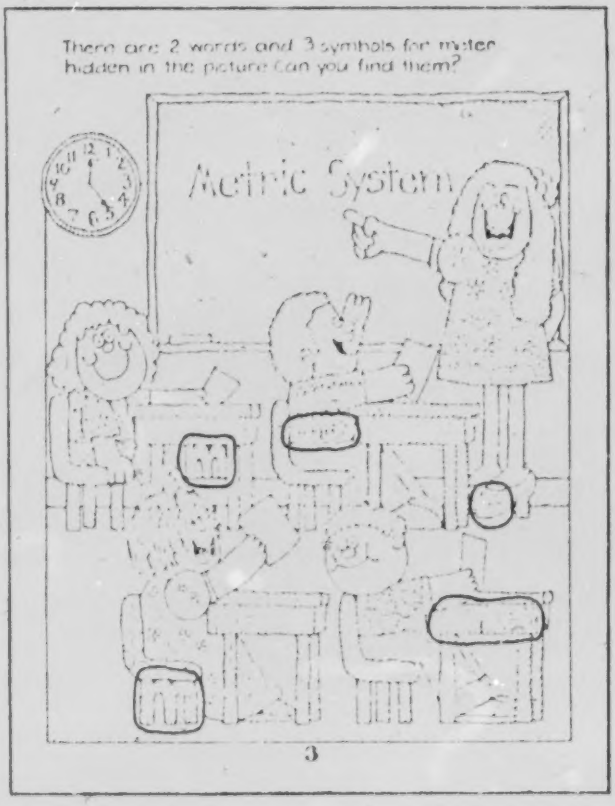
5. To reinforce proper measuring techniques, discuss page 2. Ask, "What is wrong with the first picture?" Etc.

6. Divide the class into groups of four or five students (have a good leader in each group). Explain the following challenge: Two students in each group are to stand what they think is 10 meters apart. The other two students then measure the actual distance between them to see how close their guess was. Then have students change roles (those who measured now do the standing). This time have them try to stand 8 meters apart.

7. Make up a page for homework. Typical questions might be: How tall is your bedroom door? How long is your bed? How long is your garden hose? How tall is your refrigerator? (Be prepared to replace meter strips lost or torn from this activity.)

8. Have students practice writing "meter". Quiz them to see if all students can spell it correctly. "Meter" is preferred but "metre" is also correct. Assign page 3.





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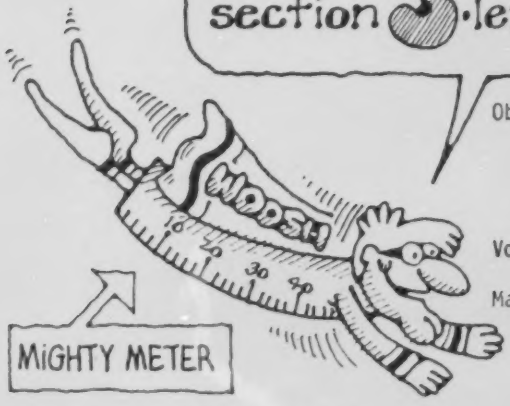
section 3 · length: decimeter



Objectives: Given a decimeter ruler, determine the length of an object (less than one meter) to the nearest decimeter.

Spell "decimeter".

Vocabulary: decimeter, dm

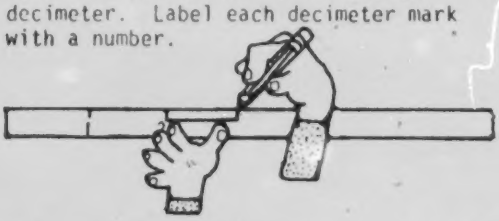
Materials: ten decimeter blocks or strips (see back of manual), meter stick, adding machine tape one meter long (student's meters from Section 2), scissors

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Ask, "How long is your metric booklet?" Bring out the inappropriateness of the meter as a unit of length for measuring small things. To measure things smaller than a meter, the inventors of the metric system divided the meter into ten equal pieces called decimeters. Hold up a decimeter. Place 10 dm blocks (or strips) against a meter stick to show that 10 dm = 1 m. Write the word "decimeter" and its symbol "dm" on the board. Explain that "deci" means "one-tenth." Have students spell the word in unison with their eyes closed.

2. Have students place their hands over a decimetre to get an idea of its length (the dm in the back of the student book can be used). Ask the children to show you how long a decimeter is with their fingers. Repeat this question from time to time.

3. As with the meter, demonstrate three different ways to measure using a decimeter: a) Using many decimeter strips laid end to end; b) using two decimeter strips in leap-frog fashion; and c) using one decimeter strip. Explain that another and more convenient way to measure distance is with a ruler with units marked on it. Cut a piece of adding machine tape 1 meter long and tape it to the board. Using a decimeter strip, start at one end and mark off each decimeter. Label each decimeter mark with a number.



Then use the decimeter ruler to measure several lengths to illustrate that it is easier to use than individual decimeters.

4. Have each student cut out one decimeter strip from the back of his book. By placing the decimeter on his own meter strip (from Section 2), have each child make his own decimeter ruler. Then play metric challenge. Draw a straight line on the board and have students estimate its length in decimeters. (Since many children are reluctant to guess for fear of being wrong, explain that at first their guesses may be way off. It might help if the teacher makes wild guesses.) Then ask a volunteer to measure it with his new ruler. Repeat several times.

5. Have students use their paper rulers to complete the exercises on page 4.

6. Write a given number of decimeters on the

board (6 dm) and ask if anyone can find something in the classroom which has the given length.

7. Review how to spell "decimeter". Have students practice writing it in their notebooks. Quiz them on both "meter" and "decimeter".

8. Draw lines on the board and have students estimate their lengths in decimeters. Then measure to see who was the closest.

My desk is about _____dm tall.

My desk top is about _____dm wide.

My desk top is about _____dm long.

My [illegible] is about _____dm long.

My waist is about _____dm.

My head is about _____dm.

4

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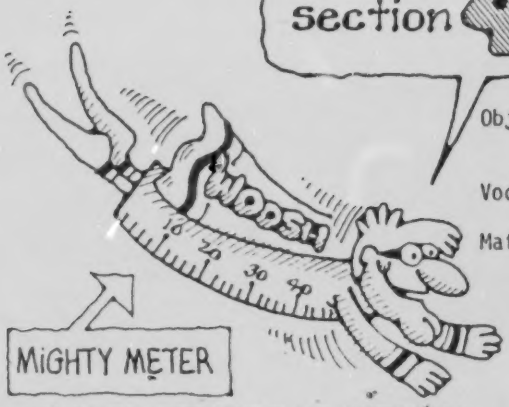
section 4 · length: centimeter



Objectives: Given a centimeter ruler, determine the length of an object to the nearest centimeter.

Vocabulary: centimeter, cm

Materials: meter stick, dm strip, several cm units (blocks or pieces of paper 1 cm long), centimeter rulers for students

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Draw a line segment about 2 cm long on the board. "Show me how long a meter is with your hands." Hold a meter stick against the line and ask, "Would you use meters to tell how long this line is?" Explain that a whole meter is too long to measure such a small length. Recall that a meter can be divided into ten equal parts called decimeters. "Show me how long a decimeter is with your hand." Hold a decimeter against the line and ask, "Would you use decimeters to tell how long this line is? The decimeter is also too long. We need a smaller unit." Hold up a centimeter unit (a block or piece of paper 1 cm long). "This is one centimeter long. A centimeter is about as wide as your finger." Write "centimeter" and its symbol "cm" on the board.

2. Have students cut out the centimeter ruler from page 57 of their booklets. Hold up a ruler and direct the students' attention to the marks and numbers on the ruler. Explain that from the end of the ruler to the first line is one cm. From the end of the ruler to the second mark is 2 cm. Etc. Draw a straight line on the board about 15 cm long. Have a volunteer measure it with his ruler. Point out that the end of the ruler should be even with the end of the line (some children may place the "1" mark at the end of the line). Repeat several times. Then have the students measure the length and width of their metric books. The length is between 21 cm and 22 cm. The width is between 16 cm and 17 cm. Discuss how to round off to the nearest cm both of these measurements. The precise measures are 21.59 cm and 16.51 cm, which makes it difficult to see with the naked eyes. Both should be rounded up (to 22 and 17 cm), but let the class decide.

3. Assign pages 5 and 6.

4. Have students compare a centimeter to a decimeter. Ask, "How many centimeters make a decimeter?" Let them measure a decimeter with their cm rulers. Write the following equations on the board and ask the students to complete them:

1 dm = 10 cm
2 dm = ____ cm
3 dm = ____ cm
4 dm = ____ cm
5 dm = ____ cm
6 dm = ____ cm
7 dm = ____ cm
8 dm = ____ cm
9 dm = ____ cm
10 dm = ____ cm

Ask, "How many centimeters are in one meter?" Bring out that 1 m = 100 cm. Tape two meter sticks end to end on the board and draw a line about 142 cm long under them. Ask how long the line is. Then count by tens (centimeters) to find the length. One meter will be 100 cm. Then count "110, 120, 130, 140, 141,

142." Draw several other lines to illustrate the procedure and let volunteers determine their lengths.

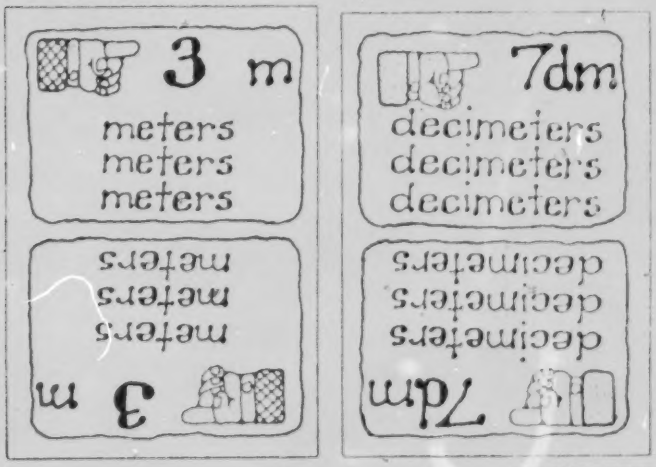
5. Assign pages 7 and 8. Tape 2 meter sticks against the wall for a height measure. Have a student stand with his back to the measure to illustrate how to determine his height. The other measurements can be done with their small cm rulers. Although spelling centimeter is not an objective, see how many students can learn to spell it.

6. Have students find a finger which is about 1 cm wide. Then have the students show you the length of a meter with their hands, the length of a decimeter with the fingers on one hand, and a centimeter with a finger. The idea is to internalize the lengths of a meter, decimeter, and centimeter in terms of something personal.

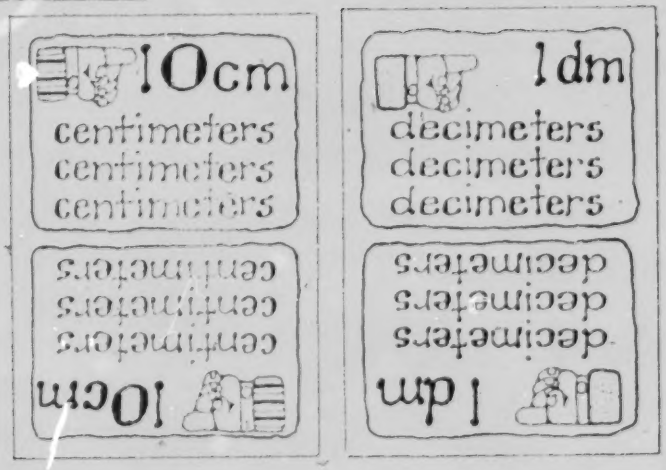
7. Teach students to play "Winner Take All." Shuffle the cards; deal them out evenly between the two players. Each player places his stack of cards face down in front of him. Each turns the first card of his deck face up. The player whose card shows the greater length wins the trick and keeps both cards face up in his winnings pile. In the event that two cards show equal lengths, those two cards are set aside and go to the winner of the trick immediately following the tie. Play continues until all cards have been turned over. The winner is the player with the most cards.

   The last 10 cards may be added to the deck to make the game more challenging after it has been played for a while.

   See pages 53-61 of the Teacher's Guide for patterns for the cards for "Winner Take All".

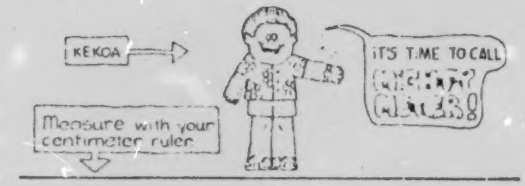


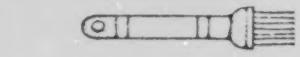
Winner takes both cards.



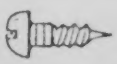
Tie trick: cards go to the winner of the next trick.

Variations: Add the 10 optional cards for a more difficult game.



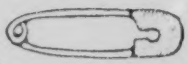


6 cm

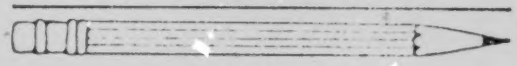


3 cm

8 cm

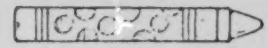


5 cm



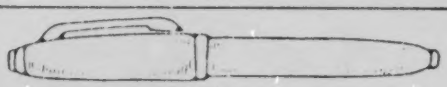
14 cm

5

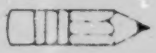


7 cm

2 cm



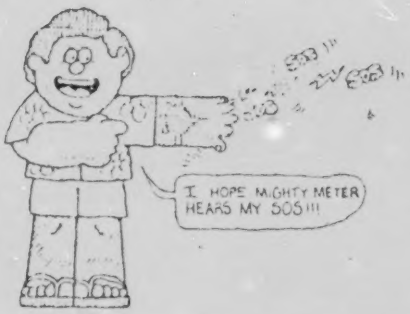
12 cm



4 cm

13 cm

6



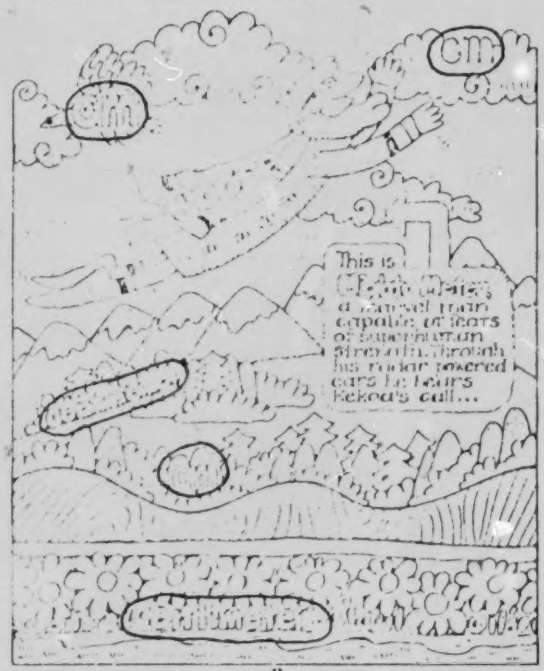
I am _____ centimeters tall.

My hand span is about _____ centimeters.

My foot is _____ centimeters long.

7

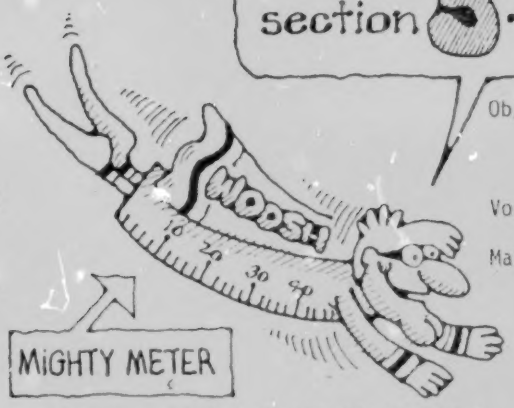
There are 2 words and 3 symbols for centimeter hidden in the picture. Can you find them?



8

the 4M company

section 5 · add units of length



Objectives: Given two expressions involving meters, decimeters, or centimeters, add and label the sum.

Vocabulary: meters (m), decimeters (dm), centimeters (cm)

Materials: adding machine tape, meter stick, dm ruler, cm ruler

SUGGESTED PROCEDURE AND ACTIVITIES:

The purpose of this section is not to teach computation. This should be done in the regular math program. Instead, this section illustrates how addition can be applied to measurement.

1. Meters. Measure and cut two pieces of adding machine tape, one 2 meters long and the other 3 meters long. Tape them (one under the other) on the board. Have a student use a meter stick to find their lengths. Write each measurement on the corresponding strip. Ask, "If we placed these end to end, how long would they be together?" Remove the strips from the board, tape them end to end on the floor, then have a student measure their total length. Record the procedure on the board:

$$\begin{array}{r} 2\,\text{m} \\ +\,3\,\text{m} \\ \hline 5\,\text{m} \end{array}$$

Do several problems on the board, explaining that adding meters is just like adding regular numbers. Stress the importance of writing the unit (m).

2. Decimeters. Cut off 2 strips of adding machine tape, one 3 decimeters long, one 5 decimeters long. As a class demonstration, let a student measure each strip; record the measures on the board. Ask, "How long a strip could I make if I taped the two strips end to end?" Tape them together (without overlap) and let a student measure the resulting strip with his dm ruler. Write the addition problem just illustrated on the board.

$$\begin{array}{r} 5\,\text{dm} \\ +\,3\,\text{dm} \\ \hline 8\,\text{dm} \end{array}$$

Write several problems on the board. Ask for answers and discuss. Remind students that dm is the symbol for decimeter.

3. Centimeters. Write a problem such as

$$\begin{array}{r} 3\,\text{cm} \\ +\,4\,\text{cm} \\ \hline \end{array}$$

on the board. Cut a strip of paper 3 cm long and another 4 cm long. Ask how long they would be if placed end to end. Tape them end to end and measure the resulting strip with a cm ruler. Write the answer.

$$\begin{array}{r} 3\,\text{cm} \\ +\,4\,\text{cm} \\ \hline 7\,\text{cm} \end{array}$$

4. Assign page 9. Point out that the first row involves meters, the second row decimeters, and the third row centimeters. Caution the students to write the correct unit (m, cm or cm). If a student gets the correct numerical answer but forgets the unit, do not count it wrong. Rather, tell the student that it is "incomplete."

5. Assign page 10. Explain how to work a secret code if this is a new kind of activity for the child.

6. For students who can "carry" in addition, assign page 11.

7. Make up a word problem involving addition of metric units. Work it on the board. Then ask each student to make up a problem of his own. Give each student a chance to read his problem.

   Example: I have 5 meters of rope. Jim gives me 3 more meters. How many meters of rope do I have altogether?

Let's add meters
Label your answers

2m + 3m	5m + 5m	3m + 4m	6m + 3m	4m + 4m	3m + 5m
5m	10m	7m	9m	8m	8m

Let's add decimeters
Label your answers

3dm + 1dm	2dm + 5dm	4dm + 5dm	8dm + 2dm	5dm + 3dm	2dm + 4dm
4dm	7dm	9dm	10dm	8dm	6dm

Let's add centimeters
Label your answers

4cm + 6cm	2cm + 2cm	1cm + 7cm	3cm + 5cm	6cm + 2cm	5cm + 4cm
10cm	4cm	8cm	6cm	8cm	9cm

9

SECRET CODE

Y	U	T	S	P	O	L	F
6cm	6dm	6m	8cm	8dm	8m	4m	4cm

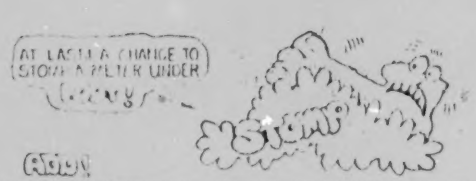
S	T	O	P
4cm + 4cm	3m + 3m	2m + 6m	7dm + 1dm
8cm	6m	8m	8dm

Y	O	U
5cm + 1cm	3m + 5m	4dm + 2dm
6cm	8m	6dm

F	O	U	L
1cm + 3cm	8m + 0m	1dm + 5dm	3m + 1m
4cm	8m	6dm	4m

F	O	O	T
4cm - 3cm	10m - 2m	2m + 6m	10m - 4m
4cm	8m	8m	6m

10

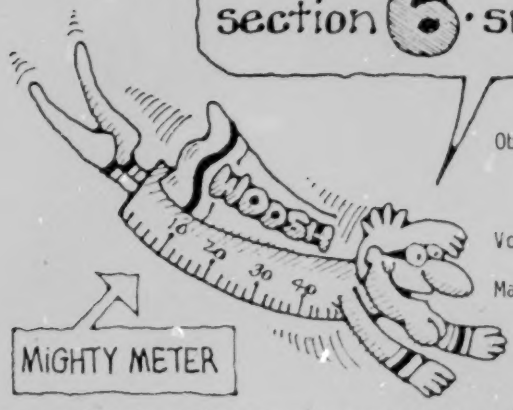


25m + 7m	18m + 6m	22m + 8m	34m + 7m	26m + 29m
32m	24m	30m	41m	55m
14m + 8m	48m + 5m	37m + 6m	56m + 7m	18m + 43m
22m	53m	43m	65m	61m
27m + 8m	19m + 7m	18m + 13m	27m + 15m	27m + 19m
35m	26m	31m	42m	46m
35m + 16m	43m + 18m	29m + 25m	27m + 27m	13m + 18m
51m	61m	55m	54m	31m
18m + 18m	15m + 28m	19m + 27m	17m + 36m	25m + 17m
36m	43m	46m	53m	42m

11

the 4th company

section 6 · subtract units of length



Objectives: Given two expressions involving meters, decimeters, or centimeters, subtract and label the difference.

Vocabulary: meter (m), decimeter (dm), centimeter (cm)

Materials: adding machine tape, dm ruler

SUGGESTED PROCEDURE AND ACTIVITIES:

The purpose of this section is not to teach computation, but rather to apply subtraction to measurement situations.

1. Cut a piece of adding machine tape 4 dm long. Have a student measure it. Then ask, "If I cut off 1 decimeter, how much would be left?" Measure and cut off 1 decimeter. Let a student measure the remaining piece. Write

$$\begin{array}{r} 4\,\text{dm} \\ -\,1\,\text{dm} \\ \hline 3\,\text{dm} \end{array}$$

on the board. Explain that subtracting measurement expressions is just like subtracting regular numbers, except that we must always include the unit: m, dm, or cm. If you think it is necessary, illustrate subtraction of meters and centimeters using real lengths.

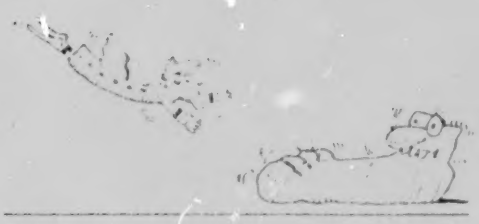
2. Assign page 12. The first row involves meters, the second decimeters, and the third centimeters. As with addition, stress the importance of the proper unit.

3. Assign the secret code on page 13.

4. Page 14 is provided for students who know how to "borrow."

5. Make up a word problem involving subtraction. Work it on the board; then have each student make up a problem of his own. Let each student pose his problem to the class.

   Example: Mighty Meter had 8 decimeters of licorice. He ate 3 decimeters. How much licorice did he have left?



Let's subtract meters.
Label your answers.

6m − 3m	7m − 2m	8m − 6m	5m − 3m	4m − 2m	8m − 4m
3m	5m	2m	2m	2m	4m

Let's subtract decimeters.
Label your answers.

9dm − 5dm	8dm − 3dm	7dm − 4dm	6dm − 2dm	5dm − 2dm	4dm − 3dm
4dm	5dm	3dm	4dm	3dm	1dm

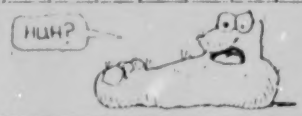
Let's subtract centimeters.
Label your answers.

10cm − 4cm	9cm − 6cm	8cm − 2cm	7cm − 5cm	10cm − 1cm	9cm − 4cm
6cm	3cm	6cm	2cm	9cm	5cm

12

SECRET CODE

B	C	E	F	G	I	M	O	R	S	T
6m	6dm	6cm	7m	7dm	7cm	8m	8dm	8cm	0m	0dm



B	I	G
3m + 3m	6cm + 1cm	2dm + 5dm
6m	7cm	7dm

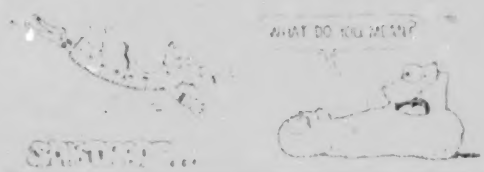
F	O	O	T	!
10m − 3m	4dm + 4dm	1dm + 7dm	8dm − 8dm	
7m	8dm	8dm	0dm	

M	E	T	R	I	C
3m + 5m	5cm + 1cm	7dm − 7dm	9cm − 1cm	6cm + 1cm	5dm + 1dm
8m	6cm	0dm	8cm	7cm	6dm

I	S
6cm + 1cm	9m − 9m
7cm	0m

B	E	S	T
7m − 1m	9cm − 3cm	9m − 9m	2dm − 2dm
6m	6cm	0m	0dm

13

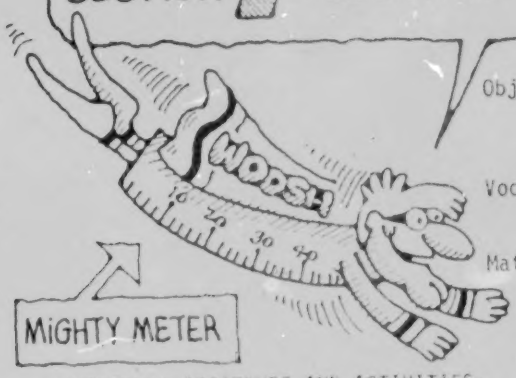


23m − 8m	21m − 5m	31m − 8m	28m − 5m	32m − 6m
15m	16m	23m	28m	36m
44m − 7m	23m − 5m	30m − 7m	40m − 5m	43m − 7m
37m	18m	29m	35m	36m
21m − 6m	22m − 4m	47m − 18m	42m − 6m	53m − 5m
15m	18m	29m	36m	48m
27m − 19m	34m − 17m	72m − 18m	36m − 29m	54m − 37m
8m	17m	54m	17m	27m
53m − 26m	74m − 39m	96m − 68m	88m − 79m	42m − 15m
27m	35m	28m	9m	27m

14

the 4m company

section 7 · decimals: measure in tenths of meters



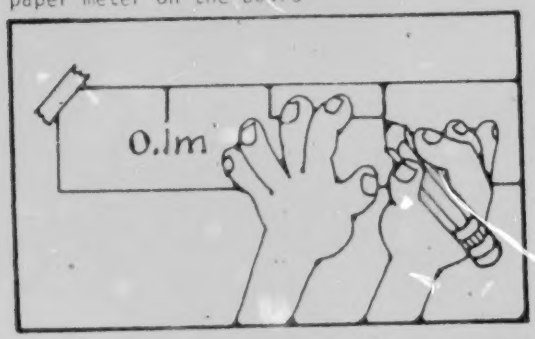
Objectives: Given a meter marked in tenths, determine the length of an object to the nearest tenth of a meter (lengths less than one meter).

Vocabulary: tenths of a meter, "___ point ___ meters", decimal

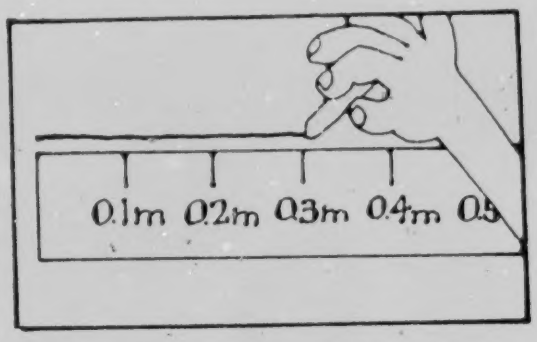
Materials: adding machine tape, decimeter strips

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Cut a strip of adding machine tape 1 m long. Ask, "How long is this strip? How many decimeters long is it?" Then place ten dm blocks (or strips) against the meter. Explain that since 10 dm = 1 m, each dm is one-tenth of a meter. Write it in two ways on the board: 1/10 m and 0.1 m. Explain that in the metric system we use the decimal form. Read 0.1 m as "one-tenth of a meter" and as "zero point one meter." Explain that two dm are 0.2 m, three dm are 0.3 m, etc. Tape the paper meter on the board



and use a dm block (or strip) to mark off dm and mark as tenths of a meter. Count each number orally: "zero point one meter, zero point two meter, ..." up to 1 meter. Repeat, having the class read with you. Then read them as tenths: "one-tenth of a meter, two-tenths of a meter, ..." Again have the class read the numbers with you. Draw a line above the meter strip which is 0.3 m long.



"This line is three-tenths of a meter long. Say it after me - three-tenths of a meter." Erase, draw a line five-tenths of a meter long. Ask, "How long is this line?" Have the class answer as a group. Repeat with other examples.

2. Have students turn to page 15. Draw a line above the meter strip. "This line is three-tenths of a meter long. We write this as ..." Write 0.3 m on the board. Then complete the activity for page 15. Draw a line above the meter and have students write its length in their booklets. Draw eight lines altogether, using the decimals shown on the answer page. Then check the answers and correct any errors.

3. Now do page 16 as a group. Read off five decimal fractions and have the

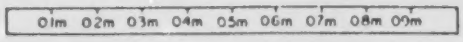
students draw lines on their paper to show how long it would be at the board. Explain that the pictures in their books are much smaller than a real meter, but that they are to draw lines to show how long it would be if they were drawing lines on the board. Use the decimals shown on the answer page.

When completed, draw lines on the board to illustrate each problem.

4. Have students take out their paper meter strips made in Section 3. They are already marked in decimeters, so have each student add zeros, decimal points, and "m's" to convert his dm ruler to a "tenths" ruler. It should look like the one on the board. (You may have to provide new strips if students have lost or mutilated their strips).

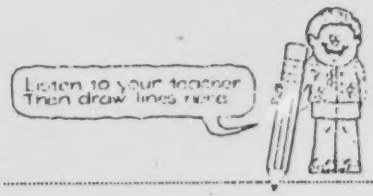
5. Do page 17 as a group. Students are to measure various lengths using their tenths ruler. Round off to the nearest tenth of a meter. Students might have to assist each other to measure their arm lengths.

Listen to your teacher Write the correct decimals here.



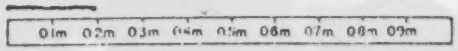
1. 0.3m
2. 0.5m
3. 0.2m
4. 0.9m
5. 0.4m
6. 0.1m
7. 0.7m
8. 0.0m

15

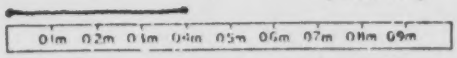


Listen to your teacher Then draw lines here.

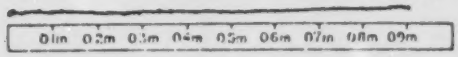
(0.2m)

1. 

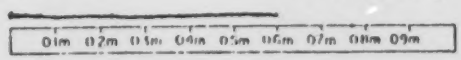
(0.4m)

2. 

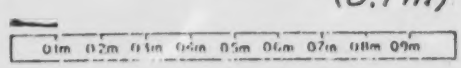
(0.9m)

3. 

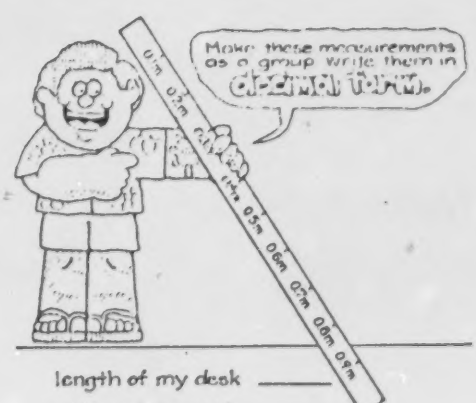
(0.6m)

4. 

(0.1m)

5. 

16

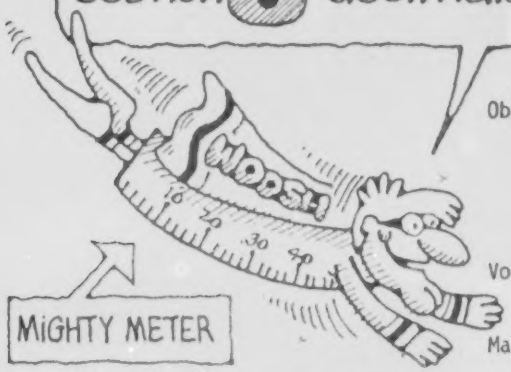


length of my desk _____
width of my desk _____
length of my metric booklet _____
width of my metric booklet _____
my waist _____
length of my arm _____
length of my foot _____

17

the 4th company

section 8 · decimals: represent tenths of meters



Objectives: Given meter and decimeter strips, write the corresponding decimal.

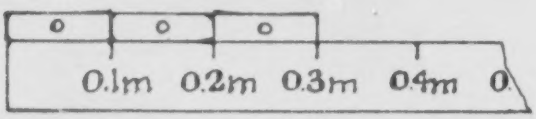
Given a meter marked in tenths, determine the length of an object to the nearest tenth of a meter (lengths greater than one meter).

Vocabulary: tenths of a meter, "___ point ___ meters", decimal

Materials: meter marked in tenths, decimeter strips, thumb tacks, adding machine tape

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Tack a meter strip marked in tenths on the bulletin board. Hold up three dm strips and ask, "If I put these end to end along this meter, how long would they be?" Then tack them above the meter to show that 3 dm placed end to end are three-tenths of a meter long.



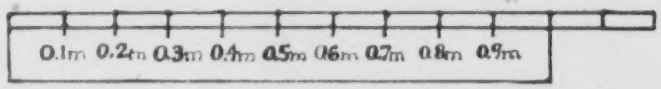
Have a volunteer write 0.3 m on the board.

2. Have students take out their meters marked in tenths and cut out the decimeter strips from the backs of their books. Have them write the symbol "dm" on the back of each strip. Hold up 2 dm strips and ask, "How long would these be placed end to end?" Have students place their strips on their meters to verify their guesses. Write 0.2 m on the board.

3. Have everyone take out a sheet of paper and number from 1 to 5. Hold up seven dm strips and ask, "How long would these be placed end to end?" Have students write the answer on a piece of paper. Then ask a student to write his answer on the board and correct any errors. Resort to the dm strips and meter strip marked in tenths if it is necessary. Do five different problems, each less than 1 meter.

4. Assign pages 18 and 19. Students are to express the decimeters as tenths of a meter.

5. To introduce decimal expressions for lengths of 1 meter or longer, use decimeter strips and the meter strip marked in tenths tacked to the bulletin board. Hold up twelve dm strips and say, "Let's see how long twelve dm strips would be if we placed them end to end." Tack them up above the meter strip.



Since 10 dm = 1 m, explain that we have 1 meter and two-tenths of a meter more. Write 1.2 m on the board. Explain that the "1" tells us how many whole meters we have, and the "2" tells us how many tenths we have. Thus, 1.2 m is two-tenths longer than 1 meter. Similarly, 1.5 m is five-tenths longer than 1 meter. Hold up one paper meter and 5 dm strips. "This is one and five-tenths meters. Who can show me what 2 and 1-tenth meter looks like?" Repeat with several more examples, letting students represent the decimal expressions with paper strips. Either have a supply of meter strips available or let students borrow them from each other. Finally, ask, "What would one and zero-tenths meter look like?" Explain that 1 m and 1.0 m are the same.

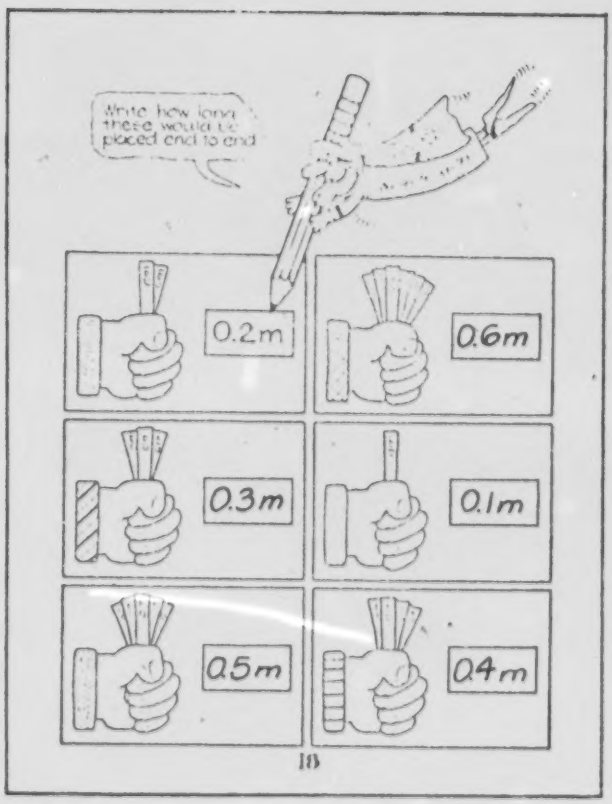
6. Hold up 1 meter and 3 dm strips and ask, "How would I write this as a decimal?" Write 1.3 m on the board. Then complete the activity on page 20. Hold up meter and decimeter strips and have students write the corresponding decimals. Do ten problems in all. Check for errors as you

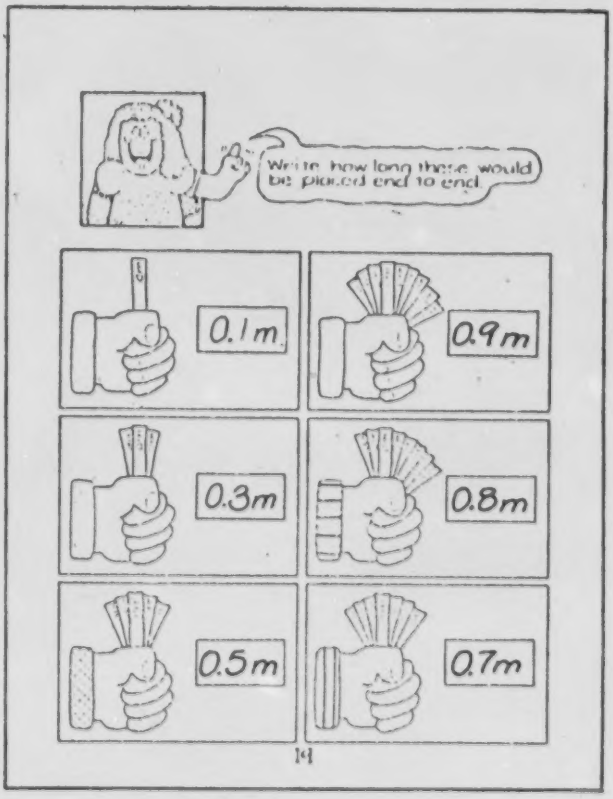
go. Use the decimals shown on the answer page.

7. Use adding machine tape to make a long number line marked in tenths of meters (at least 4 meters long). Tape or tack it to a wall. Read the entire number line: "one-tenth, two-tenths ..., three and nine-tenths." Use it to do the following group activities: point to a number and ask someone to read it; read off two numbers and ask which is longer; read off two numbers and ask for a number between them. Save the number line for Section 9. Be sure to point out that the numbers, without points, are merely consecutive integers: 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, etc. This is an easy way to remember the sequence of tenths.

8. Divide the class into five or six groups. Write a decimal measure such as 2.3 m on the board. One child from each group is to show the rest of his group how this length can be represented using meter and decimeter strips. Repeat enough times to permit each child to represent a number.

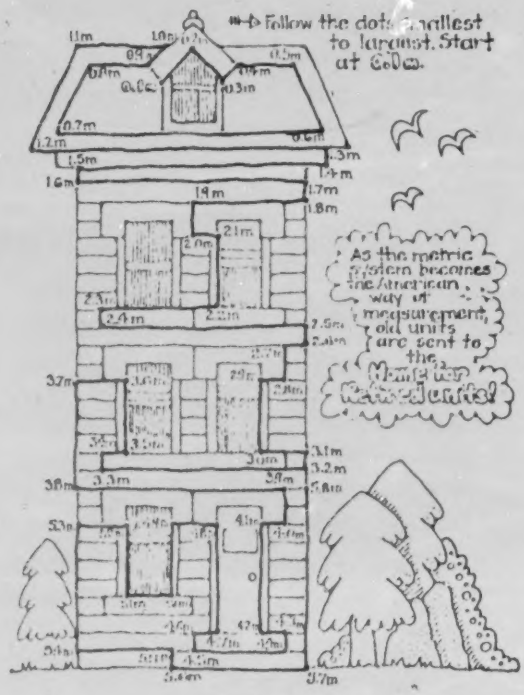
9. Label the lengths of two objects A and B. For example, the height of a bookcase might be A and the length of the bulletin board might be B. While the class is completing pages 21-22, let pairs of students measure A and B and record their answers on page 23. Check measurements as a class activity.



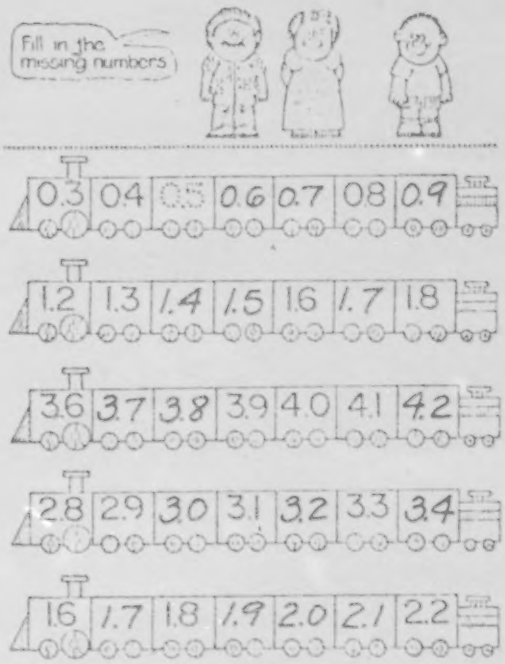


1.	1.3m	6.	0.4m
2.	1.5m	7.	1.4m
3.	2.1m	8.	3.0m
4.	4.2m	9.	0.1m
5.	1.0m	10.	3.1m

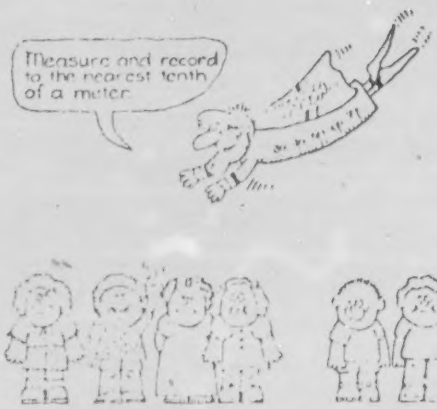
20


Follow the dots smallest to largest. Start at Golden.
As the metric system becomes the American way of measurement, old units are sent to the Museum of Natural History.

21



22



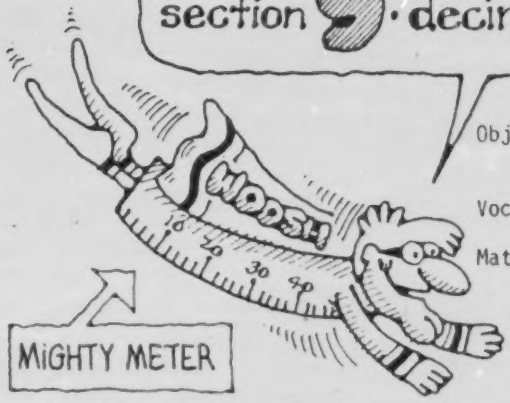
A about _____

B about _____

23

the 4M company

section 9 · decimals: add tenths of meters



Objectives: Given two expressions involving tenths of meters, add and label the sum.

Vocabulary: tenths of a meter, decimals

Materials: decimeter strips, number line marked in tenths of a meter

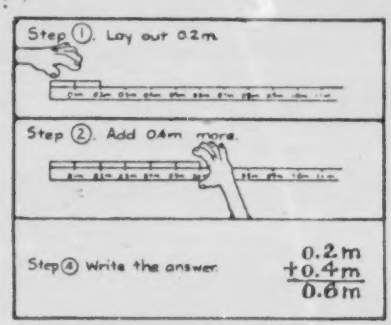
SUGGESTED PROCEDURE AND ACTIVITIES:

To teach addition of decimals it is recommended that you use the number line marked in tenths of meters (from Section 8, activity #7). If this number line is tacked or taped to a wall, decimeter strips can be taped above it to illustrate addition.

1. Ask, "How much is 0.2 m and 0.4 m?"

$$\begin{array}{r} 0.2\,m \\ +0.4\,m \\ \hline \end{array}$$

Illustrate the problem in the following way:



Repeat with several examples whose sums are less than one. Explain that adding decimals is just like adding whole numbers, except that we bring the decimal point straight down in the answer. Remind students that every measurement consists of two things, a number and a unit. So that students do not forget the decimal point or unit, it is helpful to have them write in the point and unit symbol before adding.

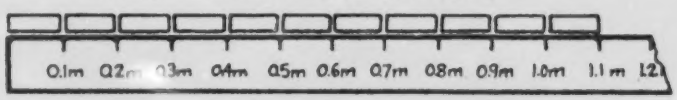
2. Work page 24 as a group discussion.

3. Assign page 25.

4. To illustrate two-digit sums, write the following problem on the board:

$$\begin{array}{r} 0.6\,m \\ +0.5\,m \\ \hline \end{array}$$

Ask the class what they think the answer will be. Tape or tack up 6 dm, then 5 dm above the meter. Read the answer and write it on the board.

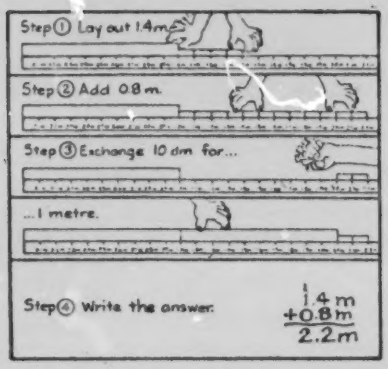


$$\begin{array}{r} 0.6\,m \\ +0.5\,m \\ \hline 1.1\,m \end{array}$$

Emphasize that 10 dm can be exchanged for 1 m. Take the 10 dm down and replace it with a paper strip one meter long. Then assign page 26.

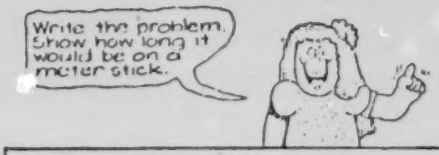
5. Page 27 involves carrying. Before assigning the page, illustrate carrying with a problem like the following:

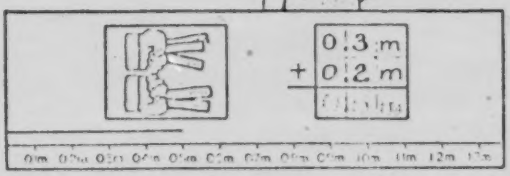
$$\begin{array}{r} 1.4\ m \\ +0.8\ m \\ \hline \end{array}$$

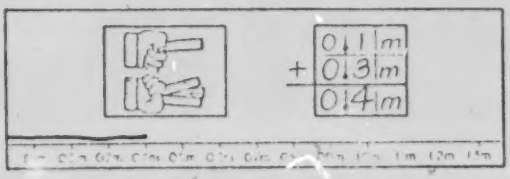


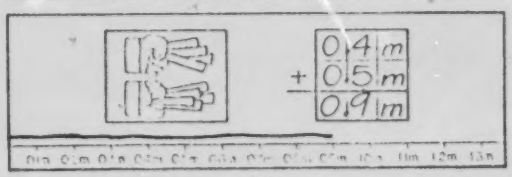
Sit down with each student to see if he can illustrate addition problems using his meter and decimeter strips. This is a good way to determine the extent of a child's understanding. Decimeter strips can be cut from the last page of the student booklet.

6. Have students make up word problems involving the addition of tenths of meters.

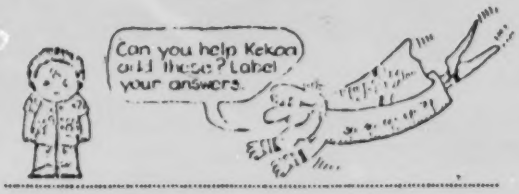






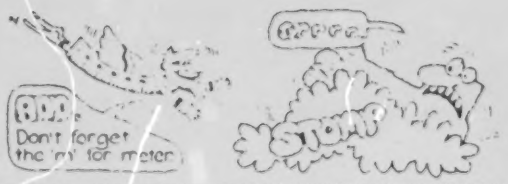


24



0.2m + 0.3m = 0.5m	0.1m + 0.1m = 0.2m	0.5m + 0.2m = 0.7m	0.4m + 0.4m = 0.8m	0.3m + 0.1m = 0.4m
0.3m + 0.4m = 0.7m	0.2m + 0.2m = 0.4m	0.6m + 0.2m = 0.8m	0.3m + 0.3m = 0.6m	0.7m + 0.1m = 0.8m
0.4m + 0.2m = 0.6m	0.5m + 0.1m = 0.6m	0.5m + 0.3m = 0.8m	0.4m + 0.5m = 0.9m	0.3m + 0.6m = 0.9m
0.7m + 0.2m = 0.9m	0.2m + 0.5m = 0.7m	0.1m + 0.3m = 0.4m	0.4m + 0.3m = 0.7m	0.3m + 0.2m = 0.5m
0.5m + 0.4m = 0.9m	0.3m + 0.5m = 0.8m	0.1m + 0.2m = 0.3m	0.2m + 0.6m = 0.8m	0.1m + 0.7m = 0.8m

25



0.8m + 0.4m = 1.2m	0.9m + 0.1m = 1.0m	0.5m + 0.5m = 1.0m	0.7m + 0.8m = 1.5m	0.4m + 0.8m = 1.2m
0.3m + 0.6m = 0.9m	0.8m + 0.3m = 1.1m	0.6m + 0.6m = 1.2m	0.9m + 0.3m = 1.2m	0.7m + 0.6m = 1.3m
0.5m + 0.9m = 1.4m	0.8m + 0.8m = 1.6m	0.7m + 0.7m = 1.4m	0.1m + 0.9m = 1.0m	0.9m + 0.9m = 1.8m
0.4m + 0.4m = 0.8m	0.3m + 0.8m = 1.1m	0.8m + 0.9m = 1.7m	0.8m + 0.6m = 1.4m	0.6m + 0.7m = 1.3m
0.3m + 0.3m = 0.6m	0.7m + 0.9m = 1.6m	0.4m + 0.9m = 1.3m	0.8m + 0.7m = 1.5m	0.6m + 0.5m = 1.1m

26

1.8m + 1.4m = 3.2m	1.7m + 0.4m = 2.1m	1.9m + 1.5m = 3.4m	2.5m + 1.6m = 4.1m	2.8m + 1.3m = 4.1m
1.6m + 1.6m = 3.2m	1.7m + 1.7m = 3.4m	1.8m + 1.8m = 3.6m	2.9m + 0.4m = 3.3m	2.6m + 0.4m = 3.0m
3.3m + 2.7m = 6.0m	4.9m + 1.3m = 6.2m	4.4m + 3.8m = 8.2m	2.5m + 2.5m = 5.0m	4.9m + 3.9m = 8.8m
3.9m + 3.8m = 7.7m	4.5m + 4.5m = 9.0m	6.6m + 2.5m = 9.1m	3.5m + 3.5m = 7.0m	8.8m + 0.5m = 9.3m
2.3m + 3.7m = 6.0m	1.9m + 4.3m = 6.2m	2.3m + 1.8m = 4.1m	1.5m + 2.6m = 4.1m	3.4m + 4.8m = 8.2m

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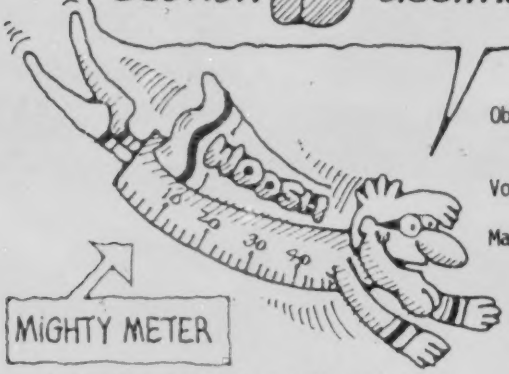
the 4M company

section 10 · decimals: subtract tenths of meters



Objectives: Given two expressions involving tenths of meters, subtract and label the difference.

Vocabulary: tenths of a meter, decimals

Materials: decimeter strips, number line marked in tenths of a meter

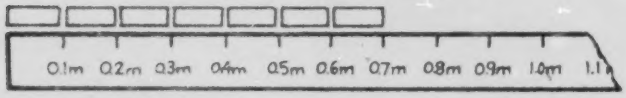
SUGGESTED PROCEDURE AND ACTIVITIES:

As in Section 9, use the number line to illustrate subtraction of tenths.

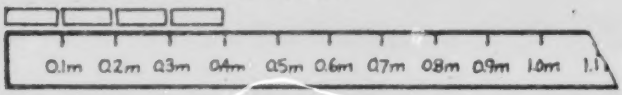
1. Ask, "If I had seven-tenths of a meter and took away three-tenths, how much would I have left?" Write

$$\begin{array}{r} 0.7\,m \\ -0.3\,m \end{array}$$

on the board. Then tape seven dm strips above the number line. Take away



three and observe that the result is four-tenths of a meter. Record the difference on the board.



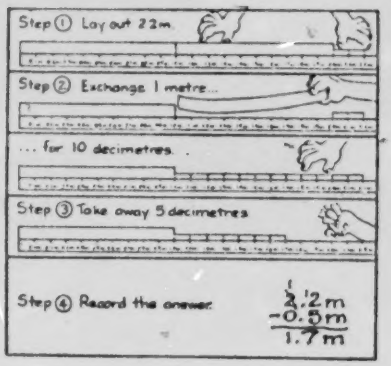
$$\begin{array}{r} 0.7\,m \\ -0.3\,m \\ \hline 0.4\,m \end{array}$$

Explain that subtracting decimals is just like subtracting whole numbers, except that we bring the decimal point straight down in the answer. Suggest the students write in the unit and the decimal point before doing the subtraction..

2. Assign page 28.

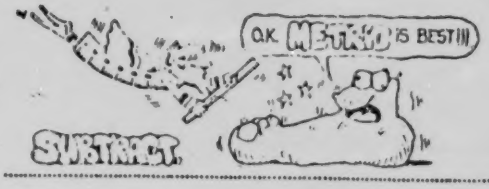
3. Page 29 involves borrowing. Before assigning the page, illustrate borrowing with the following problem:

$$\begin{array}{r} 2.2\,m \\ -0.5\,m \end{array}$$

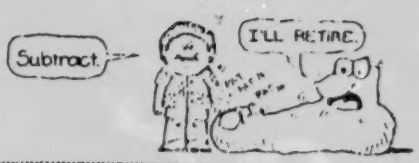


4. Sit down with each child and have him demonstrate a simple subtraction problem using his meter and decimeter strips.

5. Have each student make up one word problem involving the subtraction of tenths of meters.



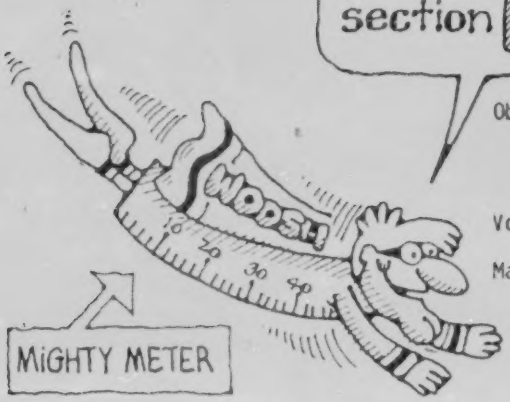
0.6m − 0.3m = 0.3m	0.8m − 0.4m = 0.4m	0.7m − 0.3m = 0.4m	0.5m − 0.2m = 0.3m	0.9m − 0.4m = 0.5m
0.4m − 0.2m = 0.2m	0.3m − 0.2m = 0.1m	0.6m − 0.4m = 0.2m	0.9m − 0.3m = 0.6m	0.8m − 0.6m = 0.2m
0.5m − 0.1m = 0.4m	0.7m − 0.5m = 0.2m	1.7m − 0.4m = 1.3m	1.4m − 0.2m = 1.2m	1.5m − 0.3m = 1.2m
1.6m − 0.2m = 1.4m	1.8m − 0.3m = 1.5m	1.9m − 0.8m = 1.1m	1.2m − 0.2m = 1.0m	1.9m − 0.6m = 1.3m
1.8m − 0.2m = 1.6m	1.6m − 0.5m = 1.1m	1.3m − 0.3m = 1.0m	1.8m − 0.5m = 1.3m	0.8m − 0.7m = 0.1m



2.3m − 0.4m = 1.9m	2.5m − 0.6m = 1.9m	2.1m − 0.8m = 1.3m	2.4m − 0.7m = 1.7m	3.3m − 1.6m = 1.7m
3.6m − 0.8m = 2.8m	3.5m − 0.9m = 2.6m	4.7m − 0.8m = 3.9m	4.2m − 0.6m = 3.6m	4.4m − 2.8m = 1.6m
3.4m − 1.7m = 1.7m	3.3m − 1.8m = 1.5m	3.3m − 1.4m = 1.9m	4.1m − 1.3m = 2.8m	2.3m − 1.6m = 0.7m
3.2m − 1.6m = 1.6m	4.5m − 2.9m = 1.6m	3.1m − 1.8m = 1.3m	4.7m − 2.9m = 1.8m	3.7m − 1.9m = 1.8m
2.2m − 1.6m = 0.6m	3.1m − 2.7m = 0.4m	1.4m − 1.7m = 0.7m	3.8m − 3.9m = 0.9m	4.2m − 0.8m = 3.4m

the 4th company

section II · capacity: liter



Objectives: Given a liter measure, determine the capacity of a container to the nearest liter.

Spell "liter".

Vocabulary: liter, ℓ

Materials: liter measure, empty half gallon milk carton, bucket, gallon jug, and a variety of containers (cup, glass, soda can, 8 oz. milk carton)

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Hold up a liter measure. Write the word and its symbol "ℓ" on the board. Explain that it is the basic unit for measuring liquid in the metric system. Compare the liter to various other containers: a cup, a glass, a soda bottle or can, an 8-ounce milk carton, and a half gallon milk carton. By looking decide which are larger and smaller than a liter. Ask questions such as, "Do you drink more or less than a liter of milk for lunch? Could you drink a whole liter of milk?" Tell the class that we'll soon be buying many things in liters: milk, gasoline, motor oil, ice cream, punch syrup, and other liquids. Show the class an empty half gallon milk carton with the top cut off at the fold. Ask, "Is this larger or smaller than a liter? How many liters of water will fit into this carton?" Then show that about 2 liters of water will fill it.

2. Use a bucket, liter measure, and water to demonstrate two ways to determine the capacity of a container: a) Fill the liter repeatedly and pour contents into the bucket until it is full. Count the number of liters as you pour each one. If the measure is not exact, explain how to round off to the nearest liter. b) Fill the bucket and dip or pour out one liter at a time, counting until the bucket is empty. Again explain rounding off. As a "Metric Challenge" let students guess the capacity (in liters) of a container, write down the guesses, then measure to see how close the guesses were.

3. Set up two large containers marked A and B at a water station. Have students work in pairs to find their capacity to the nearest liter, then record their findings on page 30.

4. While pairs of students are at the water station, let students complete pages 31 and 32.

   Adding expressions involving liters is not an objective of this lesson, but students should be able to complete page 32 following a brief explanation.

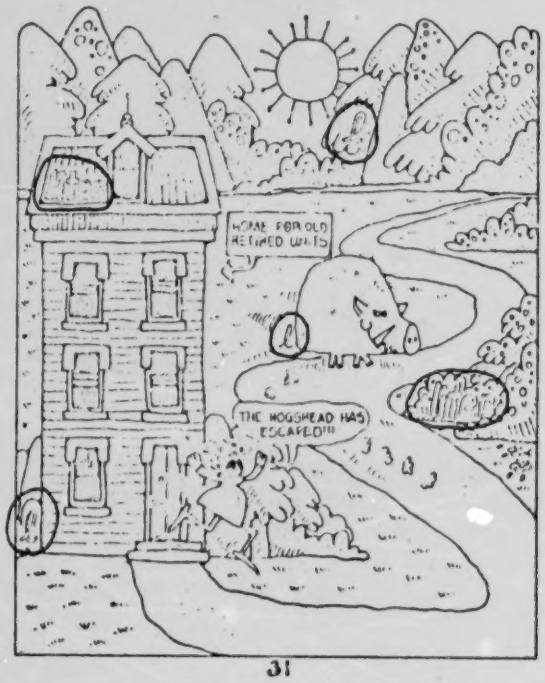
   The "hogshead" is an English unit equal to 63 gallons. You should explain this to the students when you discuss page 32.

A holds _____ liters

B holds _____ liters

30

There are 2 words and 3 symbols for liter hidden in the picture. Can you find them?



31

SECRET CODE

A	G	I	M	3	G	L	N	O	S
1ℓ	2ℓ	3ℓ	4ℓ	5ℓ	6ℓ	7ℓ	8ℓ	9ℓ	10ℓ

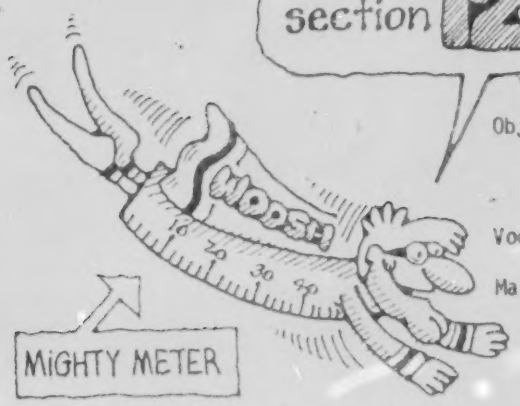
I		A	M		6	3
2ℓ +1ℓ		4ℓ −3ℓ	1ℓ +3ℓ		1ℓ +1ℓ	2ℓ +3ℓ
3ℓ		1ℓ	4ℓ		2ℓ	5ℓ

G	A	L	L	O	N	S
1ℓ +5ℓ	6ℓ −5ℓ	3ℓ +4ℓ	6ℓ +1ℓ	5ℓ +4ℓ	4ℓ +4ℓ	5ℓ +5ℓ
6ℓ	1ℓ	7ℓ	7ℓ	9ℓ	8ℓ	10ℓ

32

the 4th company

section 12 · capacity: deciliter



Objectives: Given a deciliter measure, determine the capacity of a container to the nearest deciliter.

Spell "deciliter".

Vocabulary: deciliter, dℓ, dl

Materials: deciliter measure, liter measure, 8 oz. milk carton, a variety of other containers, a centiliter measure (if available)

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Hold up a drinking glass. Ask, "How many liters does this hold?" Since it is much smaller than a liter, the liter is too large a unit for determining the volume of the glass. Discuss the need for a unit smaller than a liter. "When we needed a unit of length smaller than a meter, we used a smaller length called a decimeter. Now we have a liter and we need a smaller unit. "Here it is." Hold up a deciliter. "Can you guess its name?" Write the word "deciliter" and its symbol "dℓ" on the board. Explain that "d" stands for "deci" and that "ℓ" stands for "liter". Have the students guess how many deciliters are in a liter. Then verify that 10 dℓ = 1 ℓ. Hold up the glass again and have students guess how many deciliters it will hold. Use a one deciliter measure and water to see how close the guesses were. Guess and measure the capacities of several other containers, including an 8 ounce milk carton. Ask students how many deciliters of milk they drink for lunch.

2. Label two containers C and D and have students work in pairs to determine their capacities in deciliters. They record their findings on page 33.

3. Play the following game. Divide the class into two teams. Use a large container of water and a variety of other containers. Pour some water into a container and have one member from each team guess how many deciliters of water are in the container. Students write their guesses on small pieces of scratch paper and hand them to you.

4. Write "deciliter" on the board. Have students spell it in unison with their eyes closed. Have them write it in their notebooks 10 times. Quiz them to see that they can spell it correctly.

5. Although this level does not require measuring with the centiliter, this is a good time to introduce its existence. Hold up a small pill bottle and ask, "How many liters does this hold? How many deciliters?" Since the bottle is smaller than a liter and smaller than a deciliter, both units are too large for determining the volume of the bottle. Discuss the need for a unit smaller than a deciliter. "When we needed a unit of length smaller than a meter, we used the decimeter. When we needed an even smaller unit of length, we used a centimeter." Hold up these units and recall that 10 dm = 1 m and that 10 cm = 1 dm. "Now we need a unit of liquid that is smaller than a liter and smaller than a deciliter. Here is the unit. Can you guess its name?" Hold up a centiliter.

   Write the word "centiliter" and its symbol "cℓ" on the board. Explain that "c" stands for "centi" and that "ℓ" stands for "liter." Have the students guess how many centiliters are in a deciliter. Then verify that 10 cℓ = 1 dℓ.

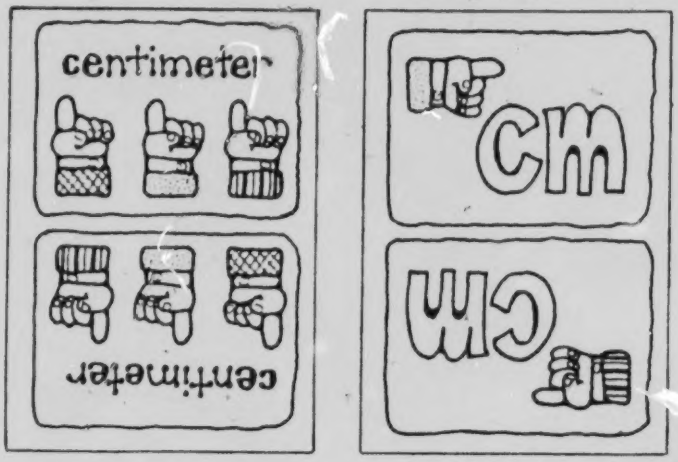
6. Use the card game Concentration to reinforce the vocabulary of unit names and symbols. The card game Jugs and Mugs reinforces the relationships between liter, dℓ and cℓ. The masters for these games are in the back of this teacher's

guide. You can duplicate them, mount them on tagboard, and laminate them if you have the facilities.

Concentration

(card game for 2 players)

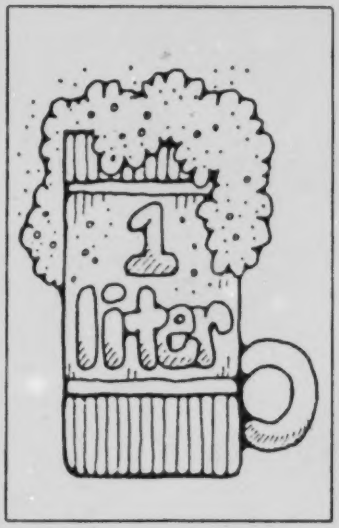
Make 24 cards for the deck. On six of them write the words meter, decimeter, centimeter, liter, deciliter, centiliter in red; on six of them write meter, decimeter, centimeter, liter, deciliter, centiliter in black. On the other 12 cards write the symbols m, dm, cm, ℓ, dℓ, cℓ, one set in red and one in black. Shuffle the cards; set them out face down in four rows of six. On his turn a player must turn over two cards, one at a time, in an effort to match the unit name to its symbol. Colors may or may not have to match depending on the level of difficulty a teacher feels her students need; establish the more suitable rule for your players. If the cards match, the player takes the pair and gets another turn. If the cards do not match, he turns them both face down and the other player has his turn. Winner is the one with the most cards after all cards have been paired.



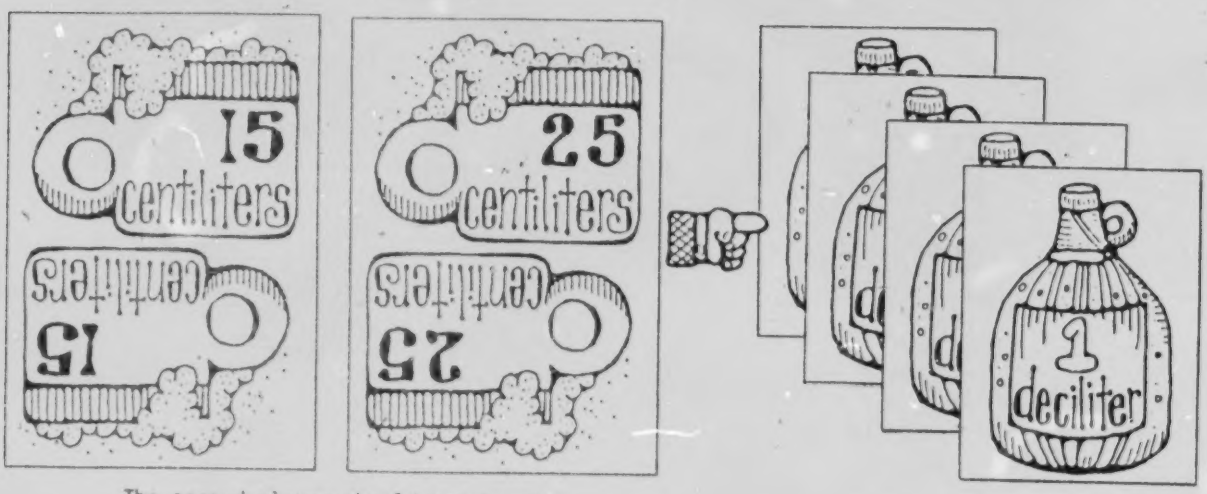
Jugs and Mugs

(card game for 4, 5 or 6 players)

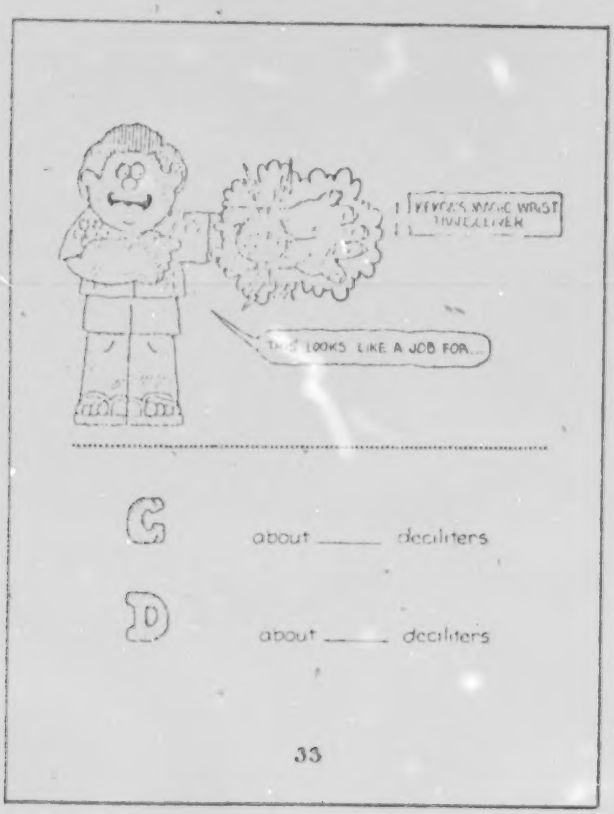
Use 40 cards with the numbers 1 to 40, one to a card, and the word centiliter on each card, also 50 cards with the word deciliter and 10 cards with the word liter printed on each. (Masters are in the back.) Appoint one person the official and give him the 30 deciliter and liter cards. Deal the deck of 40 cards, one at a time, face down to 4 or 5 players. The player to the left of the dealer then lays one of his cards face up in front of him. If he can, the next player puts down a card so that the sum of the two cards is 10 or a multiple of 10. The official then awards the second player the number of decimeter cards represented by the sum. The face up



cards are put in the discard pile, and play begins with the last person who put down a card playing another card to start a sum. If a person does not have a card that will make the sum 10 or a multiple of 10 or if he makes a mistake, play passes to the person on his left. Whenever a player collects 10 deciliter cards he should turn these in for a liter card.

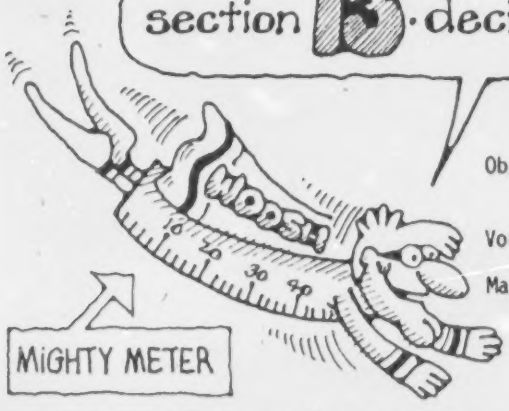


The second player should receive 4 deciliter cards for making this sum.



the 4th company

section 13 · decimals: add tenths of liters



Objectives: Given two expressions involving tenths of liters, add and label the sum.

Vocabulary: tenths of a liter, decimals

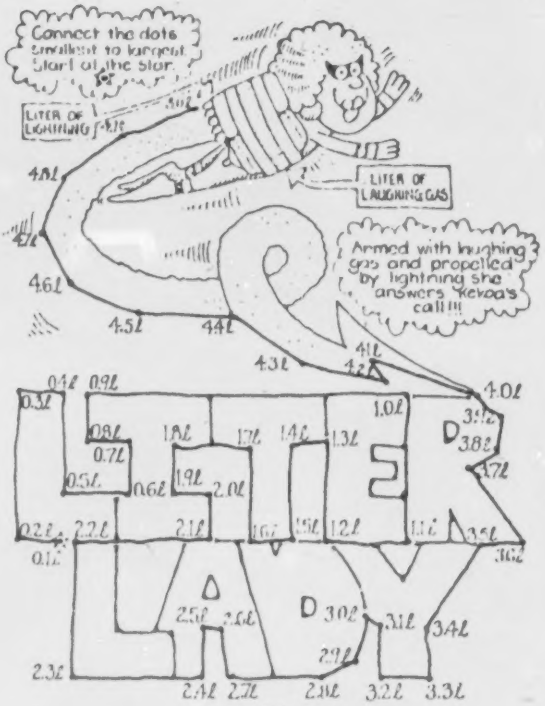
Materials: deciliter containers (3 1/2 oz. Solo cups are just the right size.)

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Just as a decimeter is one tenth of a meter, so a deciliter is one tenth of a liter. Hold up three deciliter containers and write "0.3 ℓ" on the board. Then hold up others, asking students to name the decimal they represent. Five deciliters would represent 0.5 ℓ, etc.

   Reverse the procedure. Write a decimal on the board (0.2 ℓ) and ask a student to pick up the corresponding amount in terms of deciliters (in this case, 2).

2. Explain that adding decimals is always the same, whether we are adding meters or liters. Then assign pages 34, 35, and 36. Page 36 involves carrying.



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Add Label your answers

0.3ℓ + 0.2ℓ = 0.5ℓ	0.5ℓ + 0.3ℓ = 0.8ℓ	0.4ℓ + 0.2ℓ = 0.6ℓ	0.6ℓ + 0.3ℓ = 0.9ℓ	0.2ℓ + 0.3ℓ = 0.5ℓ
0.2ℓ + 0.2ℓ = 0.4ℓ	0.4ℓ + 0.4ℓ = 0.8ℓ	0.3ℓ + 0.3ℓ = 0.6ℓ	0.4ℓ + 0.5ℓ = 0.9ℓ	0.2ℓ + 0.5ℓ = 0.7ℓ
0.8ℓ + 0.3ℓ = 1.1ℓ	0.6ℓ + 0.6ℓ = 1.2ℓ	0.7ℓ + 0.7ℓ = 1.4ℓ	0.8ℓ + 0.8ℓ = 1.6ℓ	0.9ℓ + 0.5ℓ = 1.4ℓ
0.6ℓ + 0.9ℓ = 1.5ℓ	0.8ℓ + 0.4ℓ = 1.2ℓ	0.4ℓ + 0.8ℓ = 1.2ℓ	0.7ℓ + 0.5ℓ = 1.2ℓ	0.8ℓ + 0.9ℓ = 1.7ℓ

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Add Label your answers

2.3ℓ + 5.8ℓ = 8.1ℓ	3.9ℓ + 4.3ℓ = 8.2ℓ	5.7ℓ + 1.7ℓ = 7.4ℓ	0.4ℓ + 3.6ℓ = 4.0ℓ	2.2ℓ + 1.9ℓ = 4.1ℓ
1.7ℓ + 3.3ℓ = 5.0ℓ	2.5ℓ + 3.5ℓ = 6.0ℓ	9.3ℓ + 5.8ℓ = 15.1ℓ	5.5ℓ + 2.3ℓ = 7.8ℓ	4.4ℓ + 2.2ℓ = 6.6ℓ
3.8ℓ + 5.5ℓ = 9.3ℓ	2.1ℓ + 3.7ℓ = 5.8ℓ	932.9ℓ + 90.1ℓ = 1023.0ℓ		52.7ℓ + 19.2ℓ = 71.9ℓ
0.9ℓ + 3.9ℓ = 4.8ℓ	2.8ℓ + 3.8ℓ = 6.6ℓ	6.7ℓ + 2.8ℓ = 9.5ℓ	2.9ℓ + 3.0ℓ = 5.9ℓ	0.6ℓ + 4.3ℓ = 4.9ℓ
1.1ℓ + 9.9ℓ = 11.0ℓ	123.4ℓ + 457.1ℓ = 580.5ℓ	378.1ℓ + 101.9ℓ = 480.0ℓ		67.3ℓ + 71.1ℓ = 138.4ℓ

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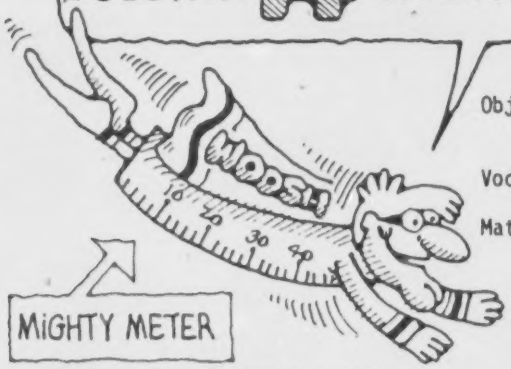
section 14 · decimals: subtract tenths of liters



Objectives: Given two expressions involving tenths of liters, subtract and label the difference.

Vocabulary: tenths of a liter, decimals

Materials: deciliter containers, (3 1/2 oz. Solo cups are just the right size)

SUGGESTED PROCEDURE AND ACTIVITIES:

This lesson is similar to the preceding one. The following steps are recommended.

1. Write a problem on the board, such as:

$$\begin{array}{r} 0.8\,\ell \\ -0.2\,\ell \\ \hline \end{array}$$

   Act out the problem, such as the following: "Suppose we had eight-tenths of a liter of milk. If I drink two-tenths of it, how much will be left?" Set out 8 deciliters, then take 2 away. "We would have six-tenths of a liter remaining."

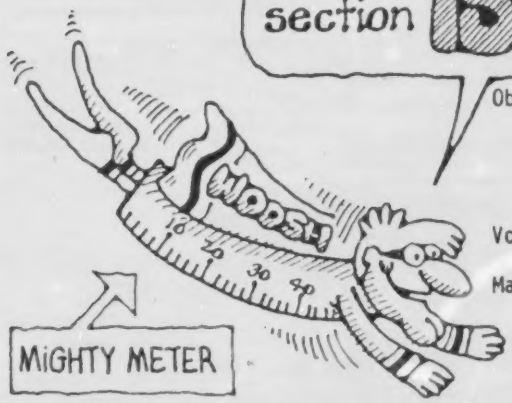
2. Assign pages 37 and 38. Page 38 involves borrowing. Explain that we merely bring down the decimal, then proceed as with regular subtraction.

0.9 ℓ − 0.5 ℓ = 0.4 ℓ	0.7 ℓ − 0.1 ℓ = 0.6 ℓ	0.8 ℓ − 0.3 ℓ = 0.5 ℓ	0.5 ℓ − 0.3 ℓ = 0.2 ℓ	0.7 ℓ − 0.5 ℓ = 0.2 ℓ
0.5 ℓ − 0.2 ℓ = 0.3 ℓ	0.6 ℓ − 0.3 ℓ = 0.3 ℓ	0.7 ℓ − 0.3 ℓ = 0.4 ℓ	0.4 ℓ − 0.2 ℓ = 0.2 ℓ	0.8 ℓ − 0.4 ℓ = 0.4 ℓ
1.4 ℓ − 0.7 ℓ = 0.7 ℓ	1.2 ℓ − 0.6 ℓ = 0.6 ℓ	1.6 ℓ − 0.8 ℓ = 0.8 ℓ	1.8 ℓ − 0.9 ℓ = 0.9 ℓ	1.1 ℓ − 0.8 ℓ = 0.3 ℓ
1.0 ℓ − 0.5 ℓ = 0.5 ℓ	1.0 ℓ − 0.4 ℓ = 0.6 ℓ	1.2 ℓ − 0.7 ℓ = 0.5 ℓ	1.0 ℓ − 0.3 ℓ = 0.7 ℓ	0.9 ℓ − 0.6 ℓ = 0.3 ℓ
0.9 ℓ − 0.3 ℓ = 0.6 ℓ	0.8 ℓ − 0.4 ℓ = 0.4 ℓ	0.7 ℓ − 0.3 ℓ = 0.4 ℓ	0.8 ℓ − 0.5 ℓ = 0.3 ℓ	0.6 ℓ − 0.2 ℓ = 0.4 ℓ

3 12 ℓ − 1.8 ℓ = 1.4 ℓ	2 13 ℓ − 0.6 ℓ = 1.9 ℓ	3 11 ℓ − 2.7 ℓ = 1.4 ℓ	4 10 ℓ − 1.3 ℓ = 3.7 ℓ	4 10 ℓ − 3.9 ℓ = 1.1 ℓ
2 13 ℓ − 1.4 ℓ = 0.9 ℓ	3 10 ℓ − 1.5 ℓ = 1.5 ℓ	6 41 ℓ − 1.8 ℓ = 4.6 ℓ	3 16 ℓ − 1.9 ℓ = 2.7 ℓ	3 12 ℓ − 0.5 ℓ = 2.7 ℓ
3 17 ℓ − 1.9 ℓ = 1.8 ℓ	2 12 ℓ − 0.5 ℓ = 2.7 ℓ	5 68 ℓ − 1.9 ℓ = 4.9 ℓ	7.4 ℓ − 1.4 ℓ = 6.0 ℓ	3 44 ℓ − 2.5 ℓ = 1.9 ℓ
6 10 ℓ − 5.1 ℓ = 1.9 ℓ	3 13 ℓ − 1.6 ℓ = 1.7 ℓ	1 31 ℓ − 0.9 ℓ = 1.2 ℓ	5 60 ℓ − 2.8 ℓ = 3.2 ℓ	7 88 ℓ − 1.9 ℓ = 6.9 ℓ
2 36 ℓ − 1.7 ℓ = 1.9 ℓ	4 31 ℓ − 4.5 ℓ = 0.6 ℓ	5 65 ℓ − 1.8 ℓ = 4.7 ℓ	5.7 ℓ − 2.3 ℓ = 3.4 ℓ	5 66 ℓ − 4.7 ℓ = 1.9 ℓ

the 4th company

section 15 · mass(weight):gram



Objectives: Given a balance and one-gram weights, determine the mass (weight) of a small object to the nearest gram.

Spell "gram".

Vocabulary: gram, g, mass, weight, "zero the scale"

Materials: two identical empty half gallon milk cartons, plastic gram weights (one per student), balance, pencil, several small objects to weigh on the balance, several cans of food (at least one marked in grams)

SUGGESTED PROCEDURE AND ACTIVITIES:

At this level no distinction need be made between mass and weight. The word "weight", as used in this program, means mass. Use the terms interchangeably with your students.

1. Before class prepare two identical empty half gallon milk cartons by putting a light weight object in one and a much heavier object in the other. Tape the tops shut. Use the cartons to introduce weight (mass). Set the two cartons before the class and observe that they look the same. "They have the same color, the same shape, the same size, the same words printed on them. Is there any way they might be different? Can we tell everything about them just by looking at them? They are different in one way." Then let a volunteer come forward. Have him pick up one carton in each hand. He should be able to tell immediately that one is heavier than the other. Point out that we can't see weight, but we can feel it. Have each child hold a book in one hand and a pencil in the other. "Can you feel which is heavier and which is lighter?" Repeat with several other objects.

   Give each child a gram weight. "Which is heavier, this gram weight or your pencil?" Hold one in each palm to show how you compare weights. Explain that we cannot always feel which is heavier. In these cases we can use a balance to tell us which is heavier.

   Demonstrate how to use a balance. When balanced, neither pan is up or down and the needle (or pointer) is directly on the middle line. (Use the white wheel to adjust the balance if it is necessary.) Place one gram weight on each side to show that when equal masses are placed on each side, the pans remain balanced. Place two weights on each side, then three, etc. Use the paper clip damper to stop the pointer.

   Take the grams off and place a pencil on one pan. "This side is heavier so it goes down." Place a gram weight on the other side. Ask, "Which is heavier, the pencil or the gram" How many grams do you think it will take to balance this pencil?" Then balance the pencil with grams. "It weighs about 5 grams." Weigh several other small objects using the balance and gram weights (crayon, eraser, etc.).

2. Explain that the gram is the unit of weight in the metric system. It is used by people all over the world to tell how heavy things are. It is used to weigh food. Bring out several cans of food and point out that weights are given in grams on the labels. Write "gram" on the board. Point out that the correct symbol for gram is "g", but that sometimes other symbols are used (gms, gr, gm, etc.). Pass around the cans and have the students find the weight of the contents. Ask students to look for labels at home which have "grams" on them. Have them bring paper labels to school and make a display

with them. Include the balance, weights, scale, etc., in the display. It can then serve as a weight station where students can experiment in their free time.

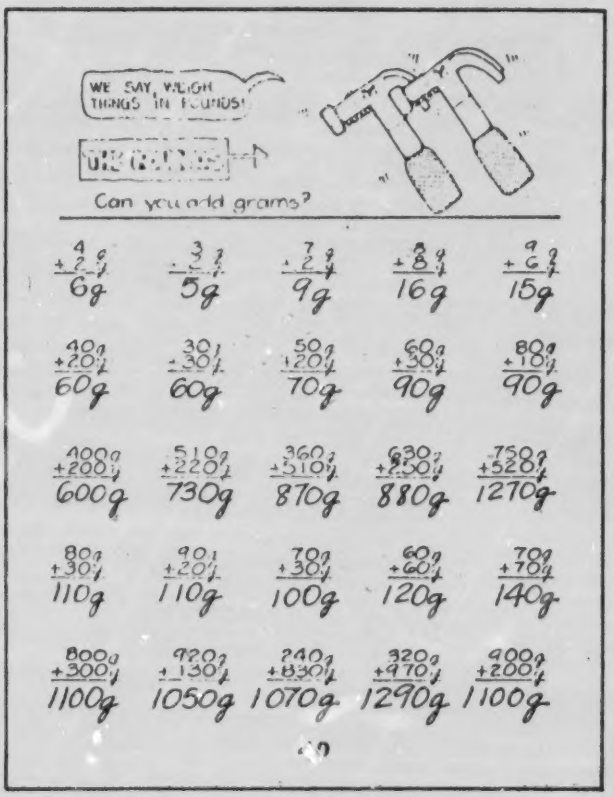
3. Set up a weighing station with the balance, 1-gram weights, and 3 objects, which weigh less than 50 grams. Label the objects L, M, and N. Let the students work in pairs at the weighing station weighing each object on the balance and recording their findings on page 39. While pairs of students take turns at the weighing station, the remainder of the class can practice spelling metric words: meter, liter, gram, decimeter, and deciliter.

4. Use two small objects, a balance, and gram weights to illustrate addition involving grams. Balance one object with grams and record its mass on the board. Then balance the other and record its mass on the board. "How much would both objects weigh together?"

   Add the two measures on the board. Then place both objects on the balance and verify the addition.

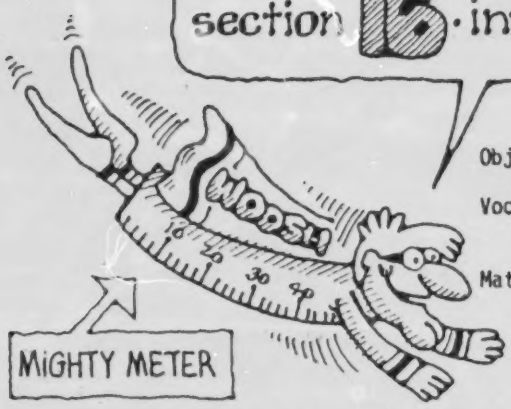
   Because slight errors can be made, it is best to choose the objects before class and verify that the sum of their masses do in fact add up properly.

   Assign page 40.



the 4th company

section 16 · introduction to the system



Objectives: none (see statement of purpose below)

Vocabulary: decigram (dg), centigram (cg), kilogram (kg), kiloliter (kℓ), kilometer (km)

Materials: meter stick, decimeter strip, liter container, deciliter container, balance, one-gram weight

SUGGESTED PROCEDURE AND ACTIVITIES:

This section has two purposes. First, to expose students to the use of metric prefixes with all three common units: meter, liter, and gram. This is the first time that the structure of the metric system is presented. Thus, we compare decimeter, deciliter, and decigram, centimeter, centiliter, and centigram, kilometer, kiloliter, and kilogram.

Second, it serves as a motivation for studying kilograms rather than decigrams and centigrams in section 17. Because decigrams and centigrams are so light, they are not used in daily living. Therefore, our strategy is to use weight (mass) to introduce the prefixes deka, hecto, and kilo.

This is an introductory section - students should not be required to memorize all of the meanings and relationships presented in this section. The metric system as a complete system will be presented at the sixth-grade level.

1. Hold up a meter and decimeter. Recall that 10 dm = 1 m. Hold up a liter and deciliter and recall that 10 dℓ = 1 ℓ. Write on the board

   1 decimeter = 0.1 meter
   1 deciliter = 0.1 liter

   This means that 10 decimeters = 1 meter, etc. Point out that the decimeter is used for measuring lengths smaller than a meter and that the deciliter is used for measuring liquid quantities smaller than a liter. Ask, "If we want to weigh something smaller than a gram, what kind of unit would we use?" Try to get them to suggest the word "decigram". Write

   1 decigram = ____ gram

   on the board. Have the class suggest that 0.1 belongs in the blank.

2. Have the students turn to page 41 and cut out the three rectangles. Use a balance and gram weight to verify that the large rectangle weighs one gram. Then have the students feel the decigram in their hand. "Can you feel how heavy a decigram is?" Point out that since it is so light it is not used very often. Place ten decigrams on the balance to show that 10 decigrams = 1 gram.

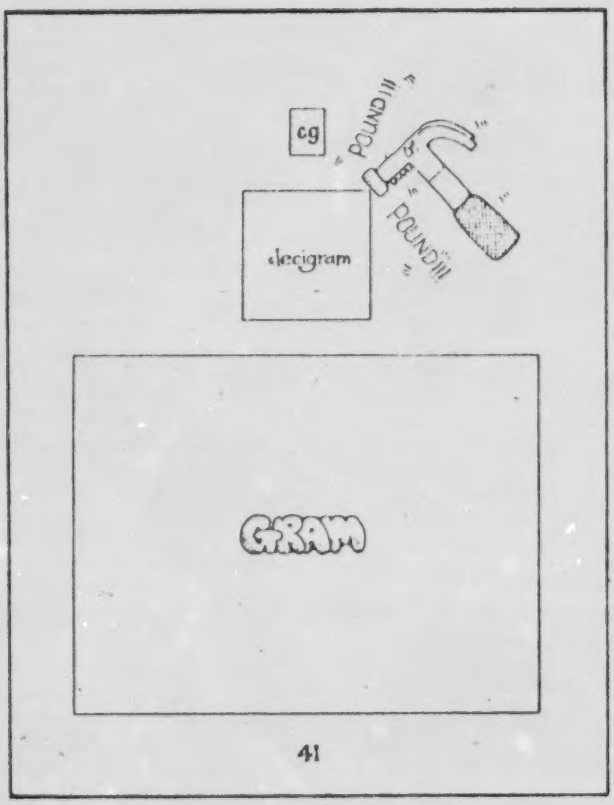
3. Next have the students "feel" a centigram weight. Point out that it would take 100 centigrams to weigh 1 gram, just as it takes 100 centimeters to make a meter and 100 centiliters to make 1 liter.

4. Turn to page 43. Have the students color in the boxes containing the units they have worked with: meter, decimeter, centimeter, liter, deciliter, centiliter, gram, decigram, centigram. Explain that all of these units are smaller than the base units (meter, liter, gram). Students will not fully comprehend the decimal notation, but explain to them that 0.1 means "one-tenth" and that 0.01 means "one-hundredth". Explain that the students will eventually learn the

meanings of all the prefixes on the chart. Go over the meaning of the prefixes deka, hecto and kilo. "Since kilo means 'one thousand', a kilometer means 'one thousand meters.' What would a kiloliter be?" Etc. Keep it brief. The idea here is exposure, not mastery.

Point out that the kilometer is used for long distances, such as between towns or countries, and that kilograms are used for weighing heavy objects.

5. You might challenge your most able students to memorize all six prefixes.



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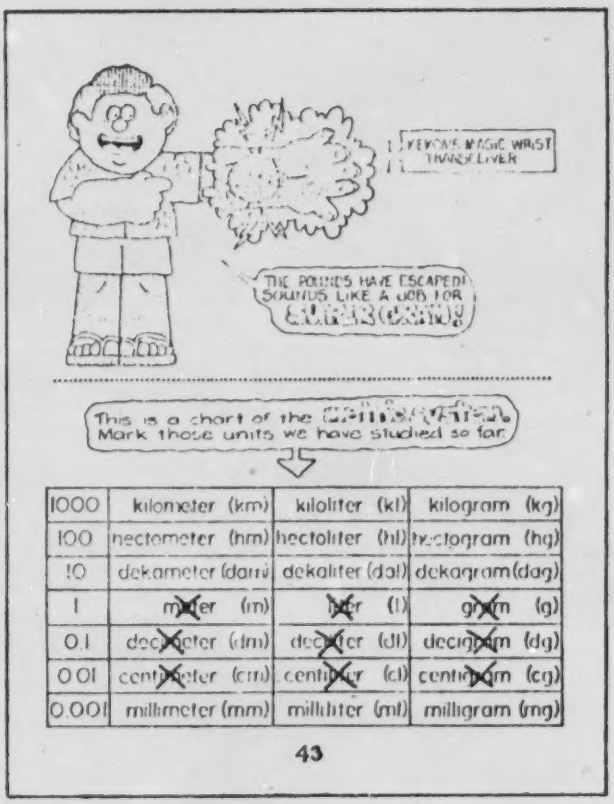
I KNOW! MAGIC WRIST THINGY-LIVER
THE POUNDS HAVE ESCAPED! SOUNDS LIKE A JOB FOR
This is a chart of the
Mark those units we have studied so far.

1000	kilometer (km)	kiloliter (kl)	kilogram (kg)
100	hectometer (hm)	hectoliter (hl)	hectogram (hg)
10	dekameter (dam)	dekaliter (dal)	dekagram (dag)
1	meter (m)	liter (l)	gram (g)
0.1	decimeter (dm)	deciliter (dl)	decigram (dg)
0.01	centimeter (cm)	centiliter (cl)	centigram (cg)
0.001	millimeter (mm)	milliliter (ml)	milligram (mg)

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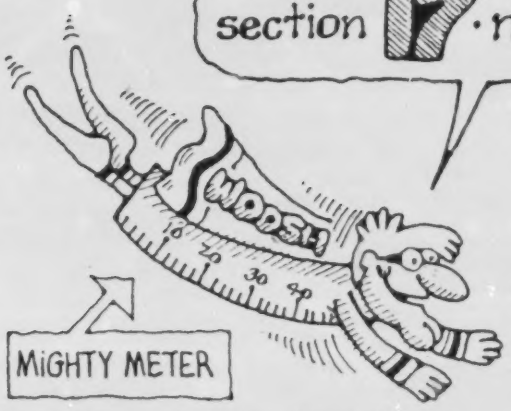
section 17 · mass (weight): kilogram



Objectives: Given a bathroom scale calibrated in kilograms, determine one's own weight to the nearest kilogram.

Given illustrations of bathroom scales calibrated in kilograms, record the indicated weight.

Vocabulary: kilogram, kg

Materials: kilogram weight, metric bathroom scale

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Hold up a kilogram weight and a 1-gram weight. Explain that the gram is very light and good for weighing small things. For heavy things we use the kilogram. Let each student hold a gram in one hand and a kilogram in the other. Write "gram" and "kilogram" on the board. Point out the word "gram" and the prefix "kilo-". Review that '"deci" means one-tenth, "centi" means one-hundredth. Ask if anyone remembers what "kilo-" means. Explain that "kilo-" means a thousand. It would take one thousand of the 1-gram weights to weigh as much as a kilogram. Write the symbol "kg" on the board explaining that the k stands for "kilo-" and the "g" for gram.

2. As a class demonstration, make a kilogram weight from an empty milk carton and sand (or rice, or water). Put the kg weight on one pan of the balance and the empty milk carton on the other. Pour sand into the carton until it just balances the kg weight.

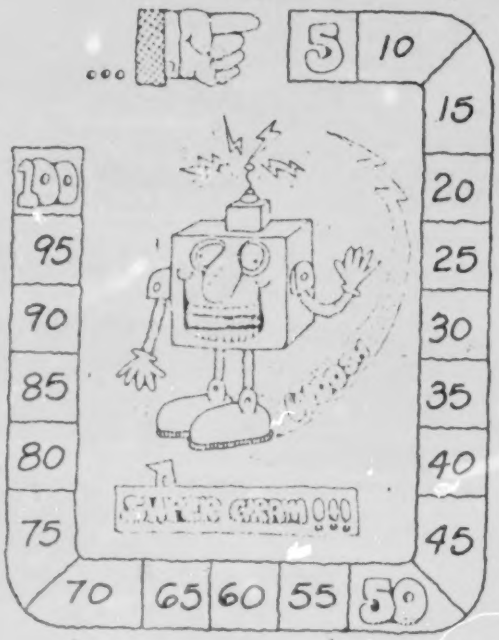
   Let students in front of the balance watch the pointer to determine when the sides are balanced. Close the carton and staple it shut. Label it "1 kg" and add it to the weight station set up in Section 15.

3. Ask, "How many kilograms do you think you weigh?" Introduce the bathroom scale, explaining that every 5 kilograms are written on the scale. Have the class count by 5's up to 130. For more practice, assign page 44.

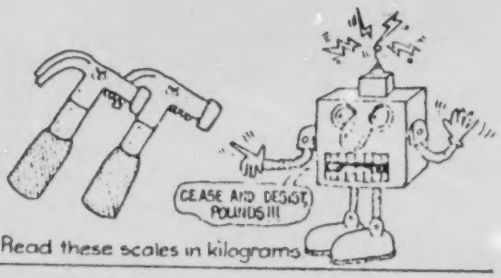
   Between each number on the scale are lines: long lines are for each kilogram, the short lines for half kilograms. Then assign pages 45 and 46.

4. While students are doing pages 45 and 46 let students come forward and weigh themselves. Supervise to see that students can read the scale correctly.

Count by 5's...



44



Read these scales in kilograms.

40 kilograms

63 kilograms

69 kilograms

25 kilograms

5 kilograms

52 kilograms

43

Read these scales in kilograms.

14 kilograms

30 kilograms

41 kilograms

32 kilograms

75 kilograms

60 kilograms

46

the 4th company

section 16 · mass(weight):add and subtract kilograms

Objectives: Given two expressions involving kilograms, add and label the sum.

Given two expressions involving kilograms, subtract and label the difference.

Vocabulary: none

Materials: metric bathroom scale

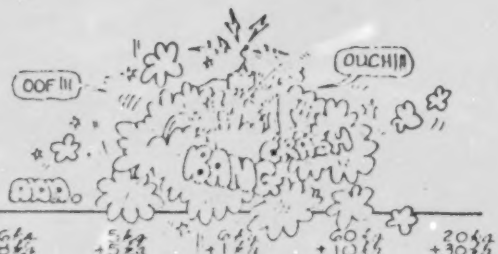
SUGGESTED PROCEDURE AND ACTIVITIES:

1. Have a student come forward (not the lightest or heaviest student in the class) and have the class estimate his weight. Weigh him and write his weight on the board. Repeat with another student. Then ask, "How much would these two students weigh if they stood on the scale at the same time?"

   Add their weights, then have both students stand on the scale at the same time and read their combined weights. Check the addition problem and the actual measured weight. Discuss any discrepancies (children were jiggling the scale, the scale might be inaccurate, etc.).

2. Assign pages 47 and 48.

3. Have students make up word problems involving kilograms.



6kg + 8kg = 14kg	5kg + 5kg = 10kg	6kg + 1kg = 7kg	60kg + 10kg = 70kg	20kg + 30kg = 50kg
1kg + 7kg = 8kg	1kg + 9kg = 10kg	7kg + 7kg = 14kg	8kg + 8kg = 16kg	5kg + 2kg = 7kg
73kg + 11kg = 84kg	52kg + 11kg = 63kg	80kg + 11kg = 91kg	28kg + 11kg = 39kg	56kg + 11kg = 67kg
10kg + 22kg = 32kg	30kg + 22kg = 52kg	60kg + 22kg = 82kg	33kg + 22kg = 55kg	55kg + 20kg = 75kg
5kg + 2kg = 7kg	9kg + 9kg = 18kg	23kg + 11kg = 34kg	9kg + 1kg = 10kg	70kg + 15kg = 85kg

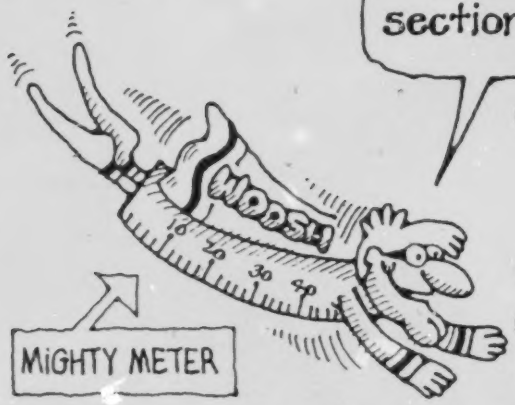
47

6kg − 3kg = 3kg	66kg − 33kg = 33kg	60kg − 30kg = 30kg	666kg − 333kg = 333kg
9kg − 4kg = 5kg	99kg − 44kg = 55kg	90kg − 40kg = 50kg	999kg − 444kg = 555kg
7kg − 2kg = 5kg	77kg − 22kg = 55kg	70kg − 40kg = 30kg	777kg − 444kg = 333kg
8kg − 2kg = 6kg	88kg − 22kg = 66kg	80kg − 20kg = 60kg	888kg − 222kg = 666kg
9kg − 7kg = 2kg	99kg − 77kg = 22kg	90kg − 70kg = 20kg	999kg − 777kg = 222kg

48

the 4th company

section 9 · perimeter



Objectives: Given a measuring tape marked in centimeters, determine the perimeter of various parts of the body.

Given a polygon with the lengths of the sides given, determine the perimeter.

Vocabulary: perimeter, distance around

Materials: cm measuring tapes, meter stick marked in centimeters

SUGGESTED PROCEDURE AND ACTIVITIES:

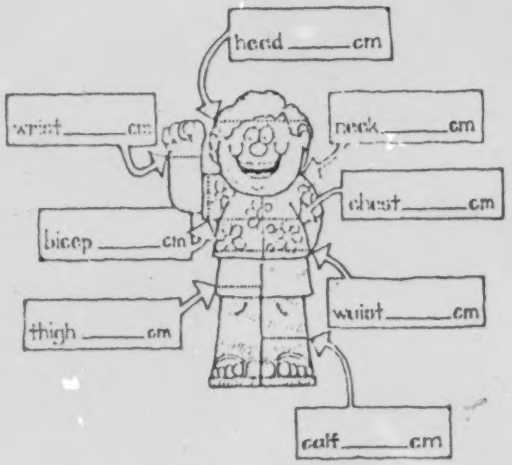
1. Explain that the distance around an object is called its perimeter. Do not expect students to remember the word "perimeter". An understanding of this concept will develop gradually over a span of several years. This is merely a first introduction to the concept.

2. Demonstrate how to use a tape measure to find the dimensions of various parts of your body. Measure your wrist, then lay the tape measure against the meter to show that the centimeters on the tape match the centimeters on the meter stick. "Since we can't bend a meter stick, we use a tape measure to find the lengths around objects."

3. Assign page 49. Let students work in twos or threes. Pair a good tutor with a slower child.

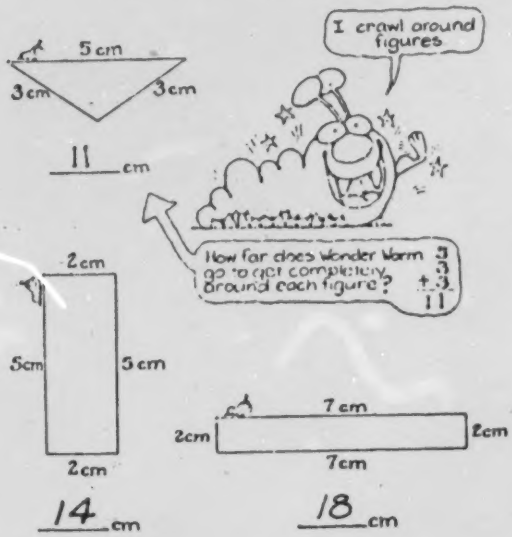
4. Assign pages 50 and 51. Explain that Wonder Worm walks around each figure to determine its perimeter.

MY MEASUREMENTS

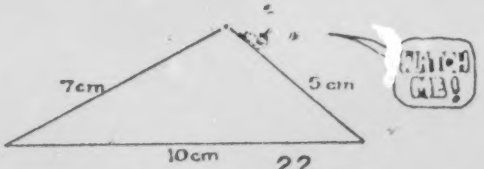


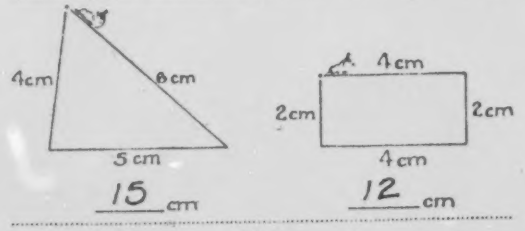
49

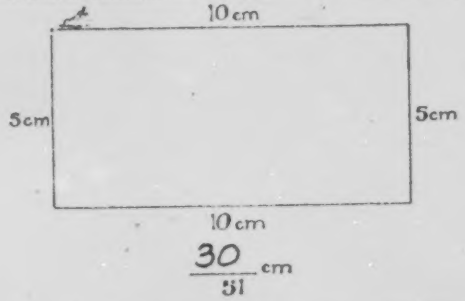
Kukoa calls on [illegible] to help Miss Aloha teach us about perimeter.



50



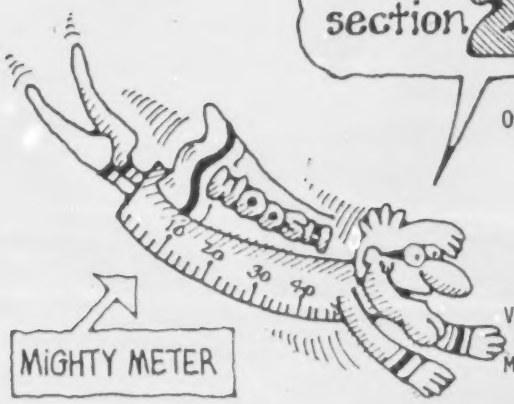




51

the 4th company

section 20 · temperature



Objectives: Given a Celsius thermometer, read the temperature to within 5 degrees.

Given an illustration of a thermometer, record the temperature to the nearest degree.

Given an illustration of a thermometer, shade it to show a specified temperature.

Vocabulary: thermometer, degrees Celsius, °C

Materials: Celsius thermometers, several glasses, ice cubes, a jar or thermos of hot or warm water

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Introduce a Celsius thermometer and ask what it is used to measure. Discuss what each of the following persons uses a thermometer for:

   doctor
   scientist
   weatherman
   mother
   nurse
   cook
   astronaut

   Call two students to demonstrate how a thermometer works. Have one student watch what happens to the red liquid when the other student places his finger over the red section, what happens when the thermometer is placed in water, etc. Have the students discover that the colored liquid in the tube moves up as the liquid is heated; and it moves down as the liquid is cooled.

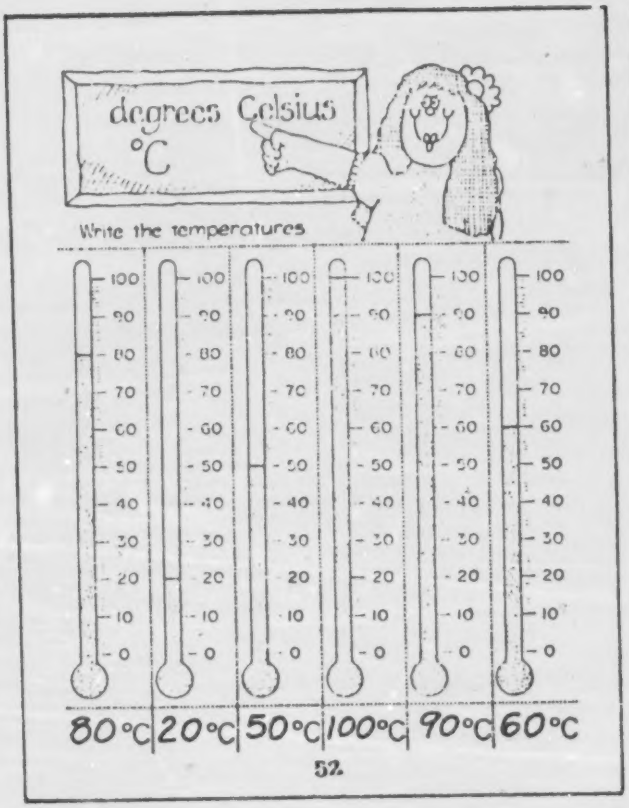
2. As a class activity, fill four glasses half way full with water. Draw four glasses on the chalkboard to record the experiment. Place no ice in the first glass, one ice cube in the second, two in the third, and three in the fourth. Then stir the first one with a thermometer for one minute. You next read the temperature; have a student record it on the board. Then stir the other glasses in succession, recording their temperatures. Discuss.

3. Set out a cup of warm water with a thermometer in it. Let one child at a time go to the cup and read the thermometer while the class is doing seatwork. The child is to write the temperature on a small slip of paper, give it to you, and sit down. The next student immediately follows. Keep the slips in order, and when all the slips are in, write the temperatures on the board in order. See if the temperature decreases. (Expect errors, of course.)

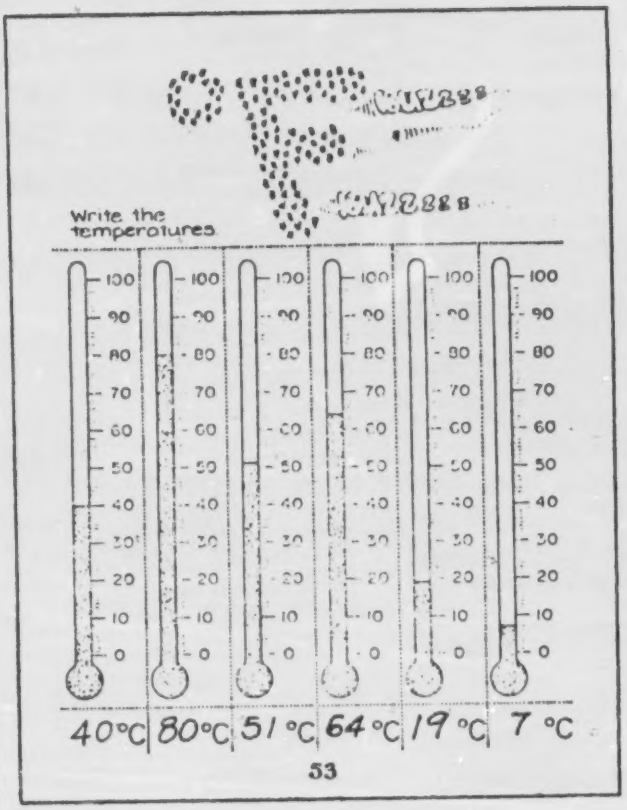
4. Assign pages 52 - 55.

5. In discussing these pages, explain that water boils at 100°C and freezes at 0°C. Normal body temperature is 37°C.

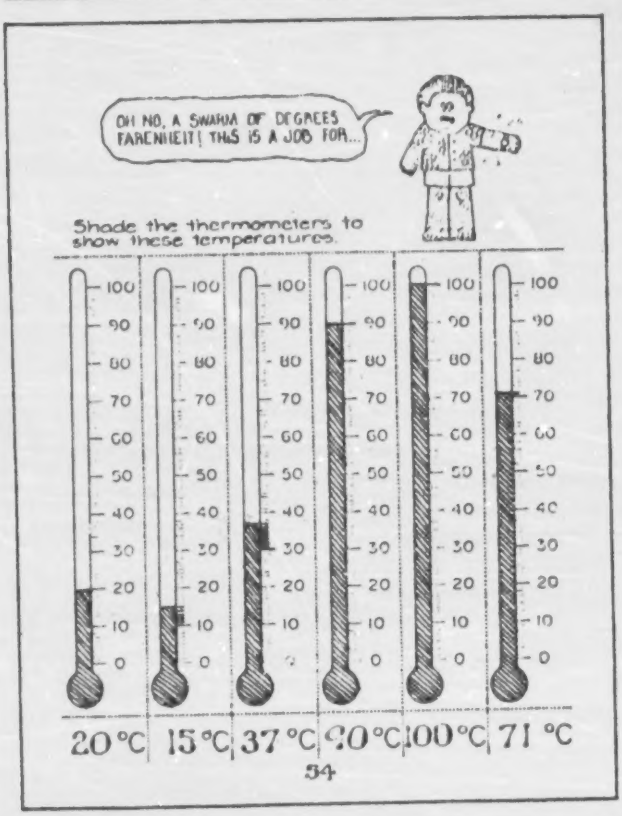
6. As a class experiment, take the temperature of four things. Students should record their findings on page 56. This is similar to a bar graph. Discuss the results.


degrees Celsius
°C
Write the temperatures
80 °C
20 °C
50 °C
100 °C
90 °C
60 °C

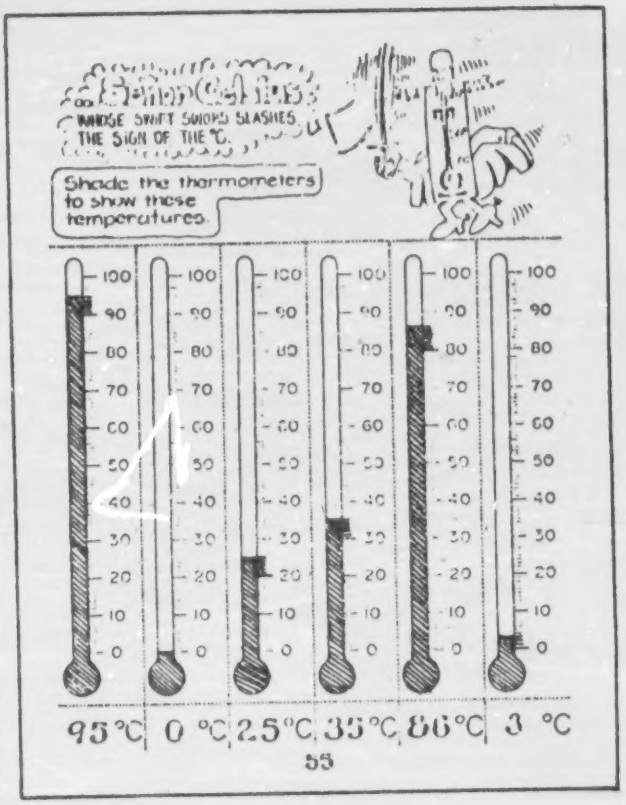
52


Write the temperatures
40 °C
80 °C
51 °C
64 °C
19 °C
7 °C

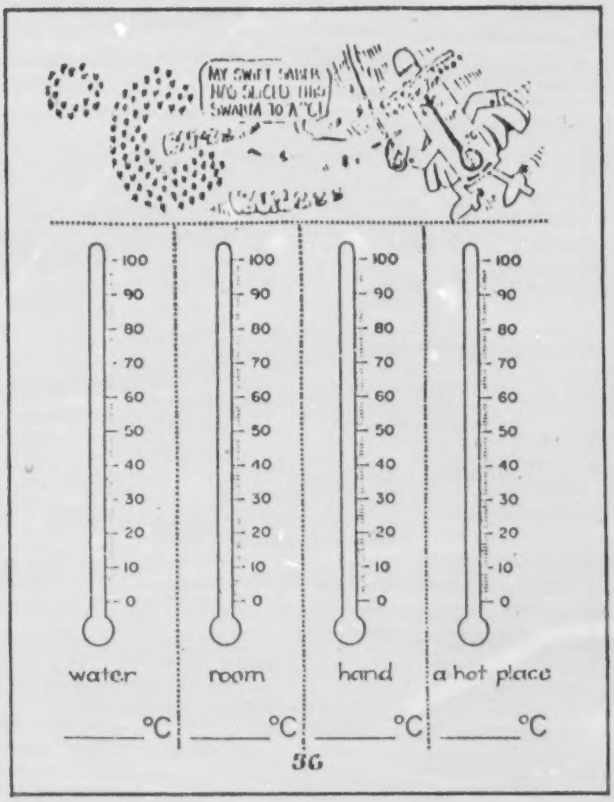
53


OH NO, A SWARM OF DEGREES FARENHEIT! THIS IS A JOB FOR...
Shade the thermometers to show these temperatures.
20 °C
15 °C
37 °C
90 °C
100 °C
71 °C

54

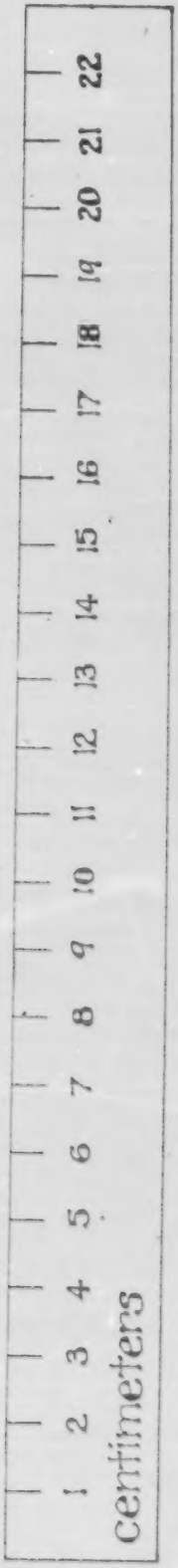

WHOOSH SWIFT SWORD SLASHES THE SIGN OF THE °C.
Shade the thermometers to show these temperatures.
95 °C
0 °C
25 °C
35 °C
86 °C
3 °C

55

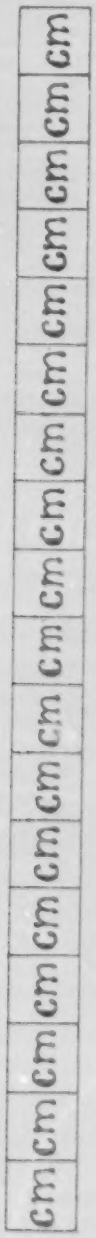


36

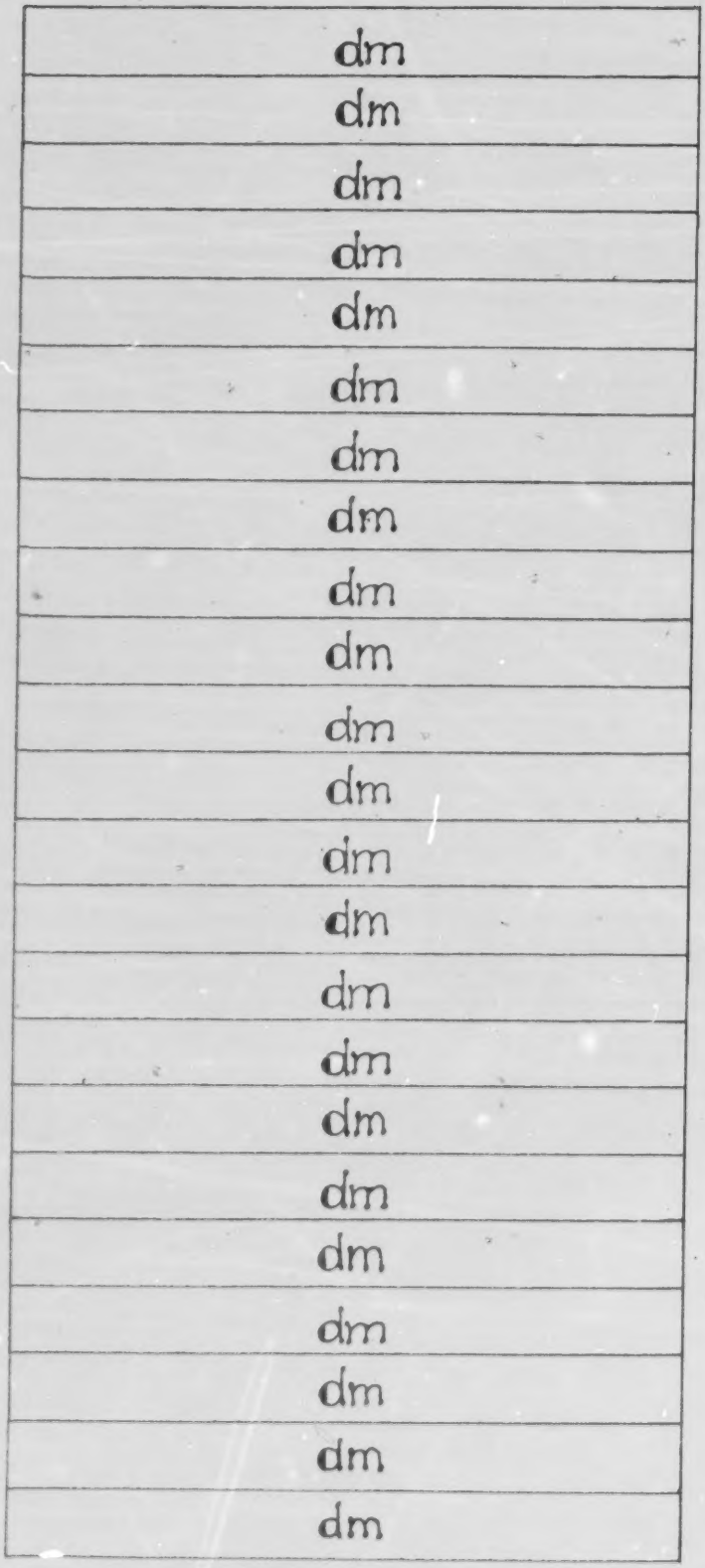
SECTION 4: student ruler. each student booklet has one of these on page 57.



SECTION 4: centimeter units



SECTION 3, 4, 7, 8, 9, 10: decimeter strips

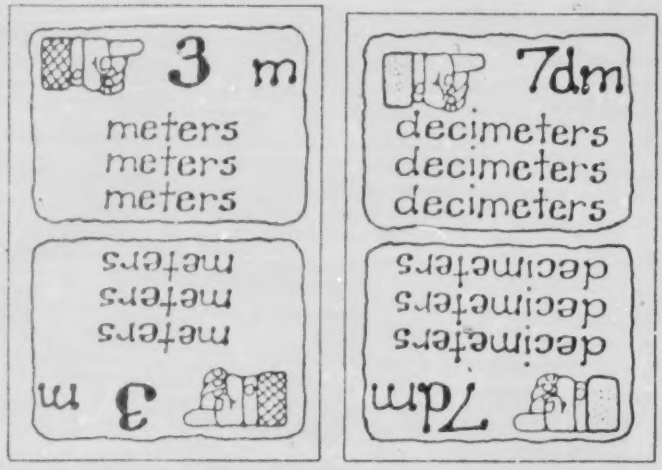


SECTION 4

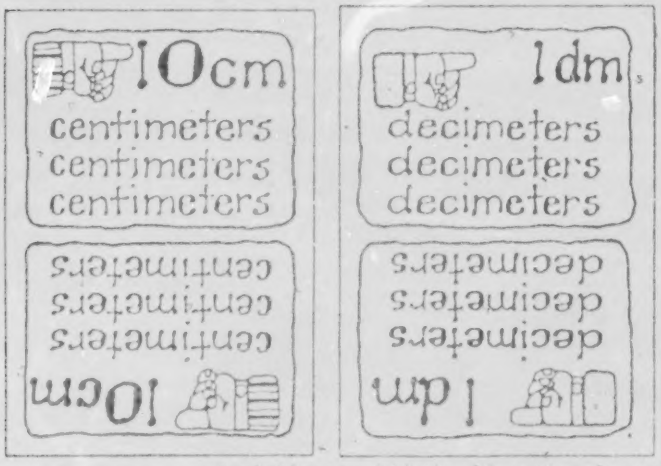
Masters for the card game Winner Take All are on this page and the next 4 pages. These masters may be used to make thermofax spirit masters and the cards run off on construction paper or similar heavy weight paper. Complete rules for the game are printed below.

Teach students to play "Winner Take All." Shuffle the cards; deal them out evenly between the two players. Each player places his stack of cards face down in front of him. Each turns the first card of his deck face up. The player whose card shows the greater length wins the trick and keeps both cards face up in his winnings pile. In the event that two cards show equal lengths, those two cards are set aside and go to the winner of the trick immediately following the tie. Play continues until all cards have been turned over. The winner is the player with the most cards.

The last 10 cards may be added to the deck to make the game more challenging after it has been played for a while.

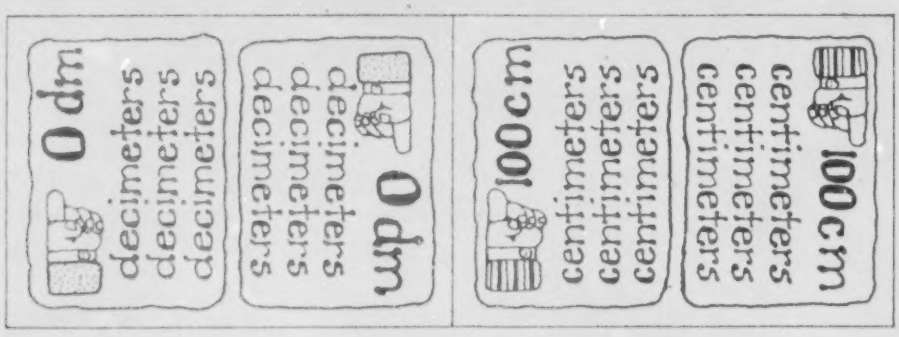


Winner takes both cards.



Tie trick: cards go to the winner of the next trick.

Variations: Add the 10 optional cards for a more difficult game.



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64

59

65

These last 10 cards may be added to the deck to make the game more challenging after it has been played for a while.

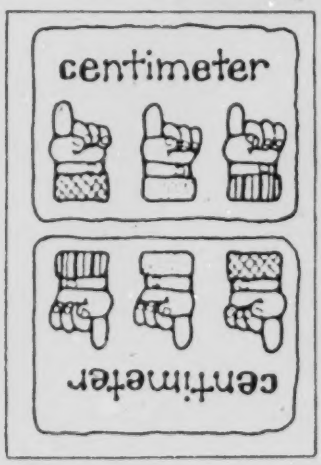
15dm decimeters decimeters decimeters	20dm decimeters decimeters decimeters	25dm decimeters decimeters decimeters	30dm decimeters decimeters decimeters	35dm decimeters decimeters decimeters
15cm centimeters centimeters centimeters	20cm centimeters centimeters centimeters	25cm centimeters centimeters centimeters	30cm centimeters centimeters centimeters	35cm centimeters centimeters centimeters

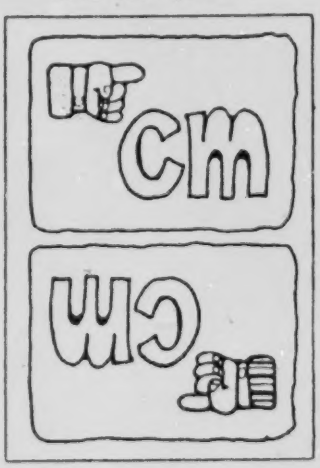
Masters for the card game Concentration are on this page and the next. Make 24 cards for the deck (2 of each of these). Mark 12 of them in red and 12 of them in black if you wish to use the color rule for your class. Complete instructions for the game follow.

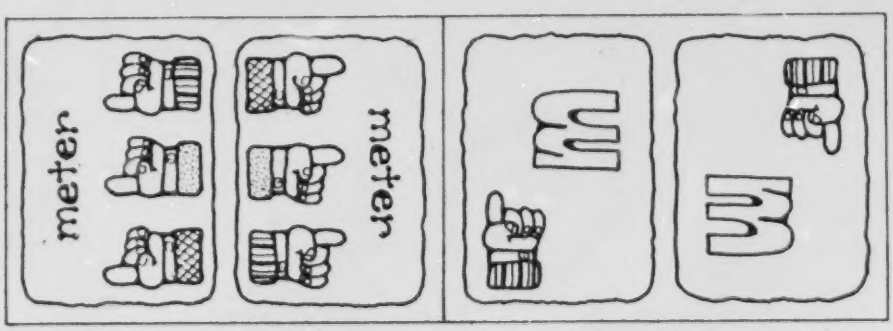
Concentration

(card game for 2 players)

Make 24 cards for the deck. On six of them write the words meter, decimeter, centimeter, liter, deciliter, centiliter in red; on six of them write meter, decimeter, centimeter, liter, deciliter, centiliter in black. On the other 12 cards write the symbols m, dm, cm, ℓ, dℓ, cℓ, one set in red and one in black. Shuffle the cards; set them out face down in four rows of six. On his turn a player must turn over two cards, one at a time, in an effort to match the unit name to its symbol. Colors may or may not have to match depending on the level of difficulty a teacher feels her students need; establish the more suitable rule for your players. If the cards match, the player takes the pair and gets another turn. If the cards do not match, he turns them both face down and the other player has his turn. Winner is the one with the most cards after all cards have been paired.







dm
cm
l
dl
cl
decimeter
centimeter
liter
deciliter
centiliter

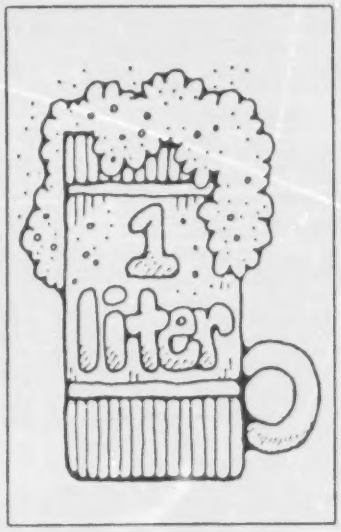
SECTION 12

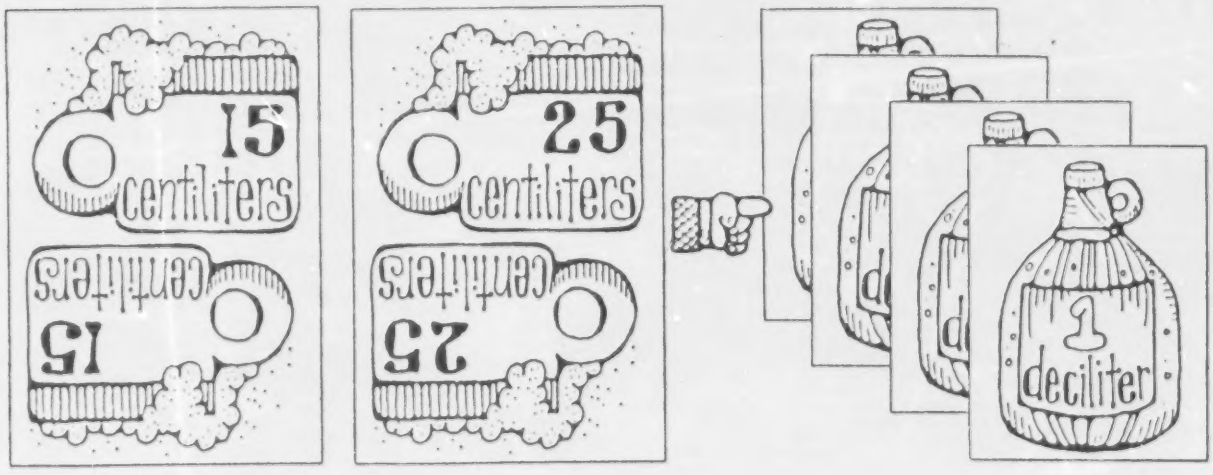
Masters for the card game Jugs and Mugs are on the following pages. They can be duplicated, mounted on tagboard, and laminated. Or you can make a thermofax spirit master and duplicate the cards on construction paper or similar heavy weight paper. Complete rules for the game are printed below.

Jugs and Mugs

(card game for 4, 5 or 6 players)

Use 40 cards with the numbers 1 to 40, one to a card, and the word centiliter on each card, also 50 cards with the word deciliter and 10 cards with the word liter printed on each. (Masters are in the back.) Appoint one person the official and give him the 30 deciliter and liter cards. Deal the deck of 40 cards, one at a time, face down to 4 or 5 players. The player to the left of the dealer then lays one of his cards face up in front of him. If he can, the next player puts down a card so that the sum of the two cards is 10 or a multiple of 10. The official then awards the second player the number of decimeter cards represented by the sum. The face up cards are put in the discard pile, and play begins with the last person who put down a card playing another card to start a sum. If a person does not have a card that will make the sum 10 or a multiple of 10 or if he makes a mistake, play passes to the person on his left. Whenever a player collects 10 deciliter cards he should turn these in for a liter card.





The second player should receive 4 deciliter cards for making this sum.

---

1 centiliter
2 centiliters
3 centiliters
4 centiliters
5 centiliters
6 centiliters
7 centiliters
8 centiliters
9 centiliters
10 centiliters

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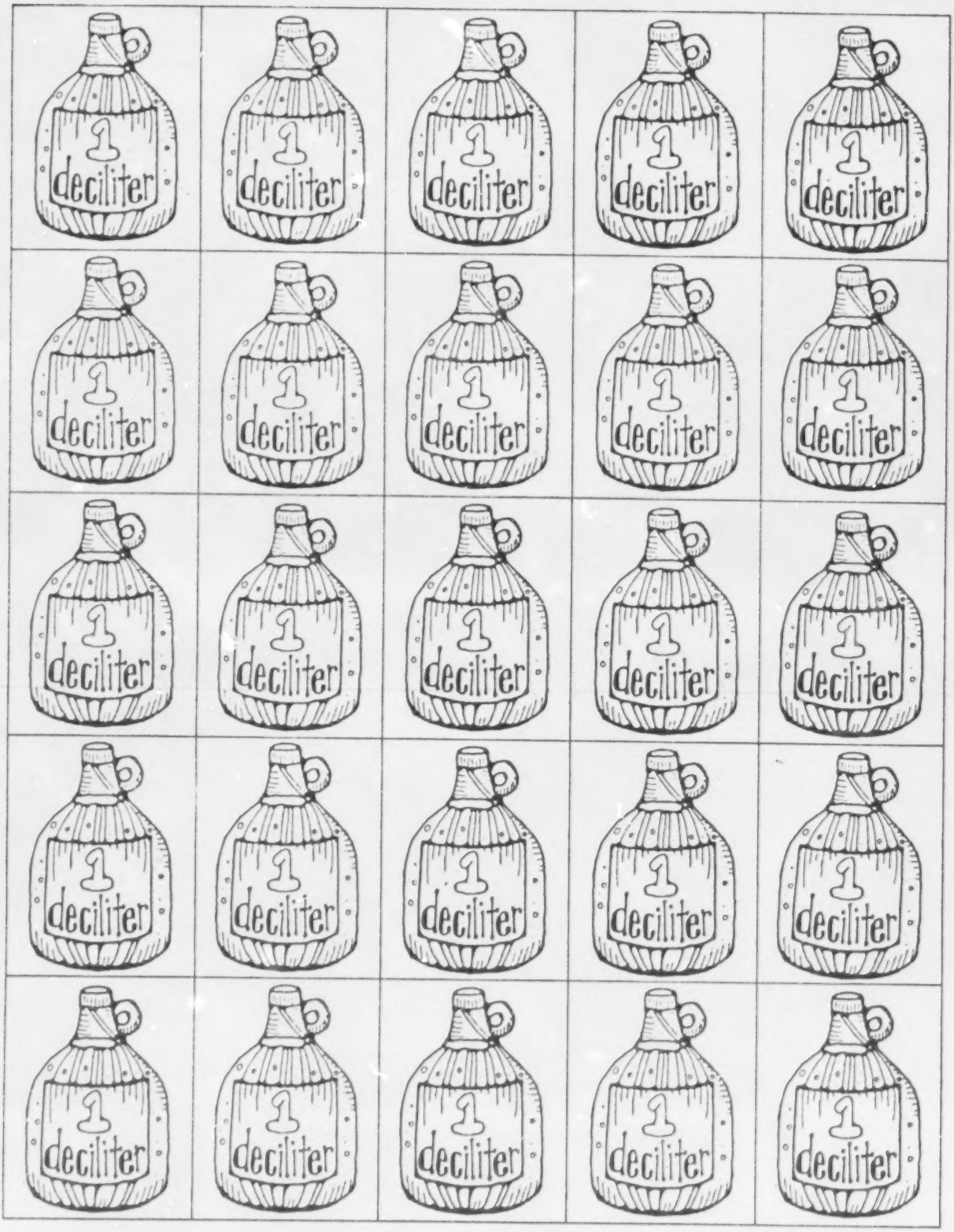
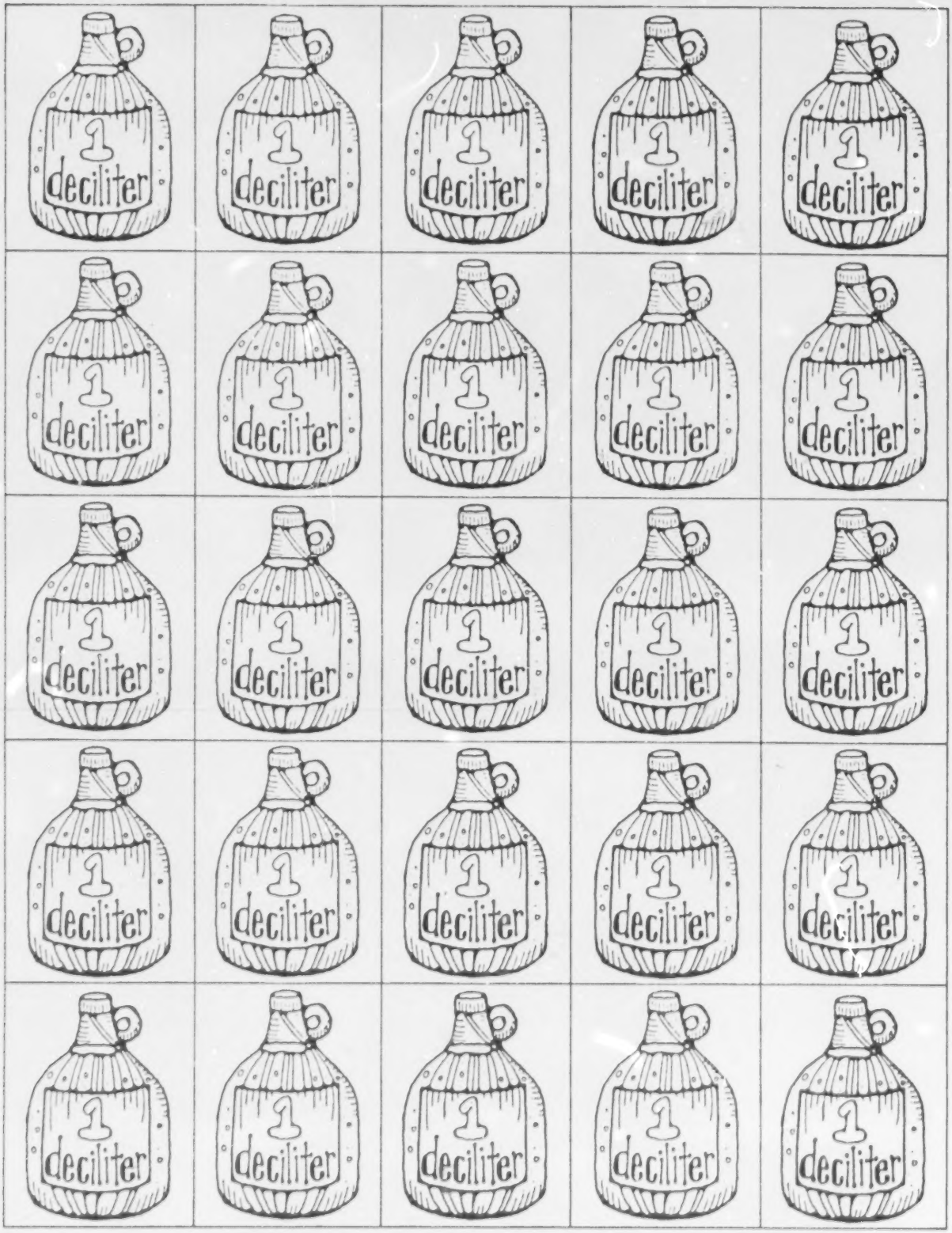

1
deciliter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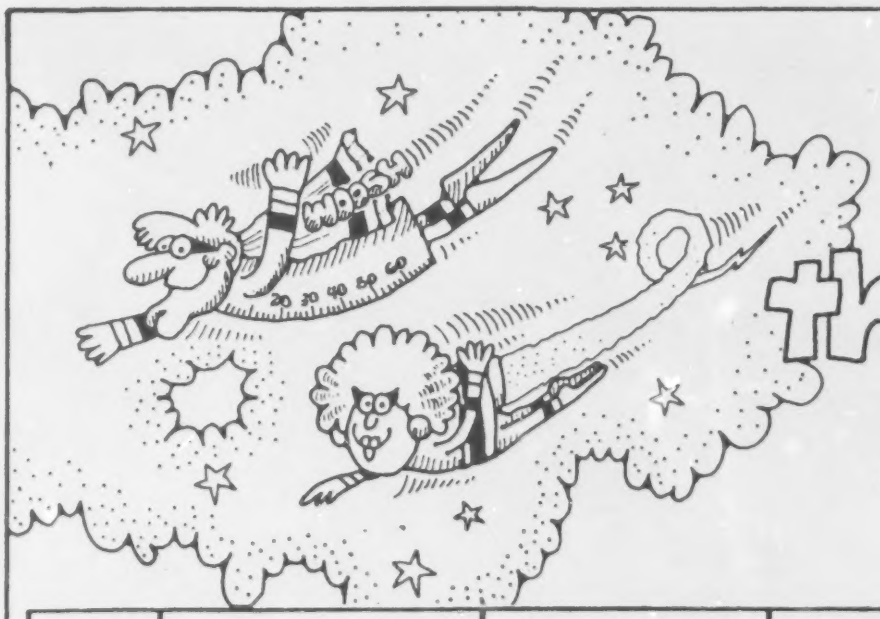
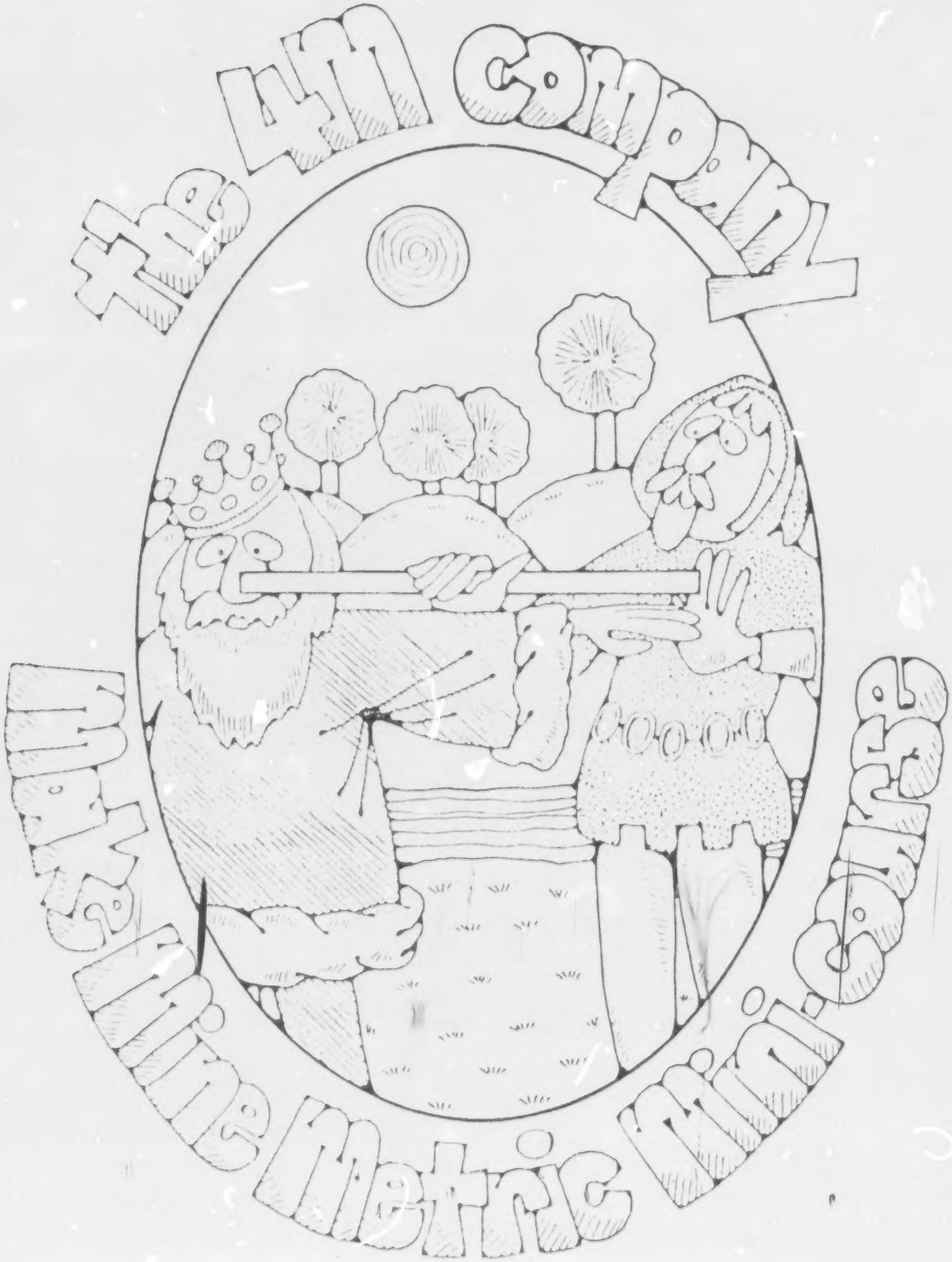


Learn the Metric System

1000	kilometer (km)	kiloliter (kl)	kilogram (kg)
100	hectometer (hm)	hectoliter (hl)	hectogram (hg)
10	dekameter (dam)	dekaliter (dal)	dekagram (dag)
1	meter (m)	liter (l)	gram (g)
0.1	decimeter (dm)	deciliter (dl)	decigram (dg)
0.01	centimeter (cm)	centiliter (cl)	centigram (cg)
0.001	millimeter (mm)	milliliter (ml)	milligram (mg)



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INTRODUCTION

This mini-course is designed to serve two purposes: 1) a quick review of metrics for teachers who have attended a metric workshop; and 2) a basic introduction to the metric system for teachers who have not attended a metric workshop. If studied seriously, we feel the contents of this mini-course can prepare a teacher to teach the metric system. However, don't expect to be an expert right away. Even teachers who have attended a workshop frequently forget much of what they learned. As most teachers know, we usually don't know a subject well until we have taught it a time or two. The same will be true of metrics.

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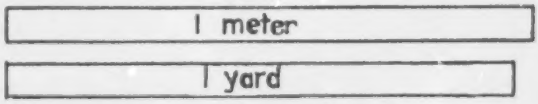
LESSON 1: THE METER, THE LITER, AND THE GRAM

The three most common metric units are the meter (for measuring length or distance), the liter (for measuring liquid or granular capacity), and the gram (for measuring weight). Select a meter, a liter, and a gram from your metric supplies.

The meter is the main unit of length in the metric system. Stand up and hold the meter stick on the floor against your leg. How high up your leg does it come? To your hip? To your waist? Remember the spot and you'll always have some idea of a meter. A meter is just a little longer than a yard -- 39.36 inches.



The liter is the main unit of capacity in the metric system. It was originally defined to be the capacity of a cube each of whose sides was 1/10th of a meter long.

Take a good look at the liter. Does it appear to be about the size of any English unit? Actually, the liter is slightly larger than a quart (6% larger, to be exact).

Now pick up the gram, the main unit of weight in the metric system. Pretty light, isn't it? If you look at the protein, fat, and carbohydrate content of the sides of cereal boxes you'll notice that the weights are given in grams. A paper clip weighs about one gram. A nickel weighs 5 grams.

weighs 1 gram

weighs 5 grams

These three units - meter, liter, and gram - are the heart of the metric system necessary for everyday measuring. Try to remember the size of each unit: the meter is a little longer than one yard; a liter is a little larger than a quart; and a gram is the weight of a paper clip.

LESSON 2: OTHER UNITS - PRESTO!

In the English system of measurement there are 14 units of length, and there is no systematic relationship between them:

12 inches = 1 foot

3 feet = 1 yard

5½ yards = 1 rod

40 rods = 1 furlong

8 furlongs = 1 mile

etc.

One would have to be a near-genius to remember all the relationships in the English system!

By comparison, the metric system is simple (although it may not seem so at first). In the metric system there is one base unit for each physical property to be measured. To form units larger or smaller than the base units, a system of prefixes, each of which is a power of ten, is used. For units smaller than the base units, the Latin words for tenth, hundredth, and thousandth are used (deci, centi, and milli). To form units larger than the base units, the Greek words for ten, hundred, and thousand are used (deka, hecto, and kilo). The new units are formed by placing the prefixes in front of the base units.

	LENGTH	CAPACITY	MASS (WEIGHT)
1000	kilometer (km)	kiloliter (kℓ)	kilogram (kg)
100	hectometer (hm)	hectoliter (hℓ)	hectogram (hg)
10	dekameter (dam)	dekaliter (daℓ)	dekagram (dag)
1	meter (m)	liter (ℓ)	gram (g)
0.1	decimeter (dm)	deciliter (dℓ)	decigram (dg)
0.01	centimeter (cm)	centiliter (cℓ)	centigram (cg)
0.001	millimeter (mm)	milliliter (mℓ)	milligram (mg)

Whenever kilo is heard, we know immediately that we have 1000 of the base unit, whatever it is. Thus, kilometer is 1000 meters, kiloliter is 1000 liters, kilowatt is 1000 watts, etc. (The watt is a unit of power.) Or, millimeter is 0.001 meter, milliliter is 0.001 liter, etc.

The writing of metric units is simplified by the use of symbols: m stands for milli, c for centi, d for deci, da for deka (the a is needed to distinguish deci from deka, both of which start with d), h for hecto, and k for kilo. Also, m for meter, ℓ for liter, and g for gram. Thus kg is kilogram, mℓ is milliliter, etc. In the next lesson you will practice using these metric prefixes.

LESSON 3: PRACTICE WITH PREFIXES

In this lesson you will practice using metric prefixes. Use the table in Lesson 2 to help you complete the following equations. Answers appear at the end of the Teacher's Guide.

100 grams =	hectogram	100 liters =	
10 liters =		1000 liters =	
1000 meters =		1000 grams =	
0.001 gram =		10 meters =	
100 liters =		0.1 meter =	
0.01 gram =		0.1 liter =	
0.001 meter =		0.01 liter =	
0.01 meter =		0.1 gram =	
0.001 liter =		10 grams =	

Keep going! Try these!

10 cards = dekacards (get it?)

0.1 Arnaz =

0.01 mentalist =

1000 manjaros =

0.001 tary =

0.1 mate =

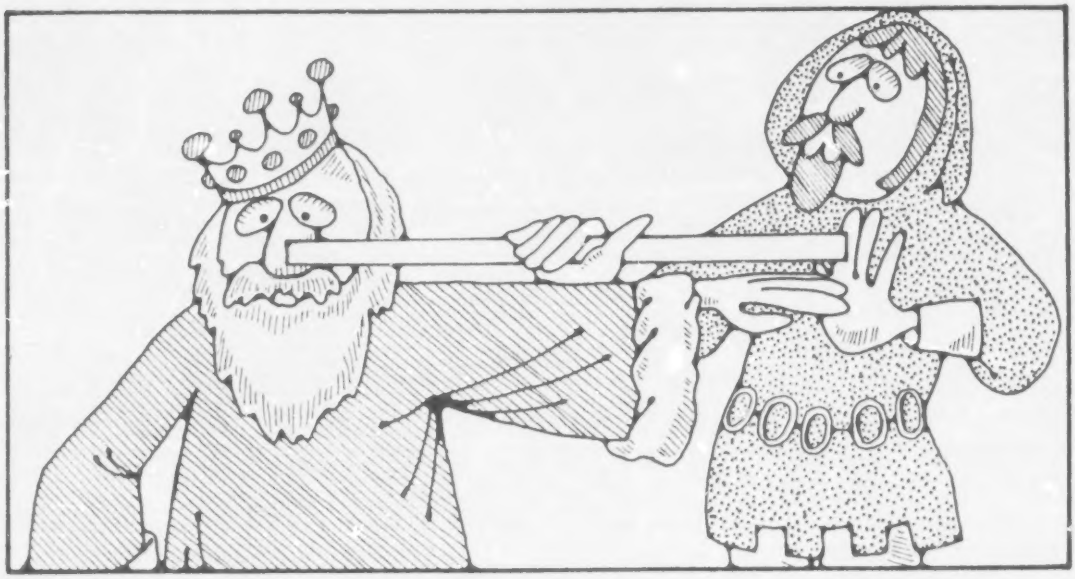
1000 whats? =

0.001 scent =

0.01 pede =

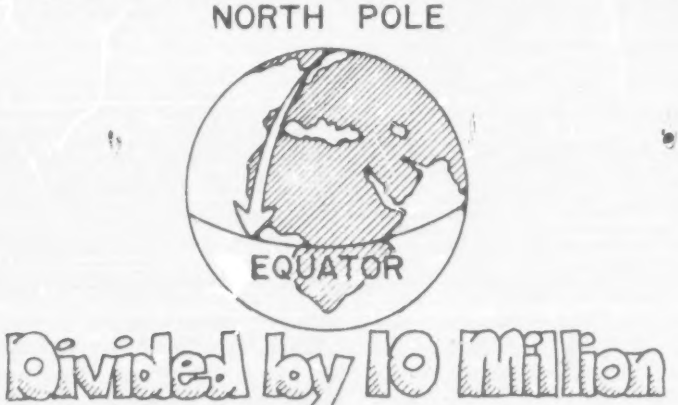
LESSON 4: A BRIEF HISTORY OF THE METRIC SYSTEM

Prior to 1790, the measurement systems of Europe were based on arbitrary objects: an inch was once defined to be the length of 3 kernels of barley corn placed end-to-end; a rod was the combined left feet of the first 16 men coming out of a specific church on Sunday morning; an acre was the amount of land a team of oxen could plow in one day; the yard was the distance from the tip of King Henry I's nose to the tip of his extended middle finger; etc.

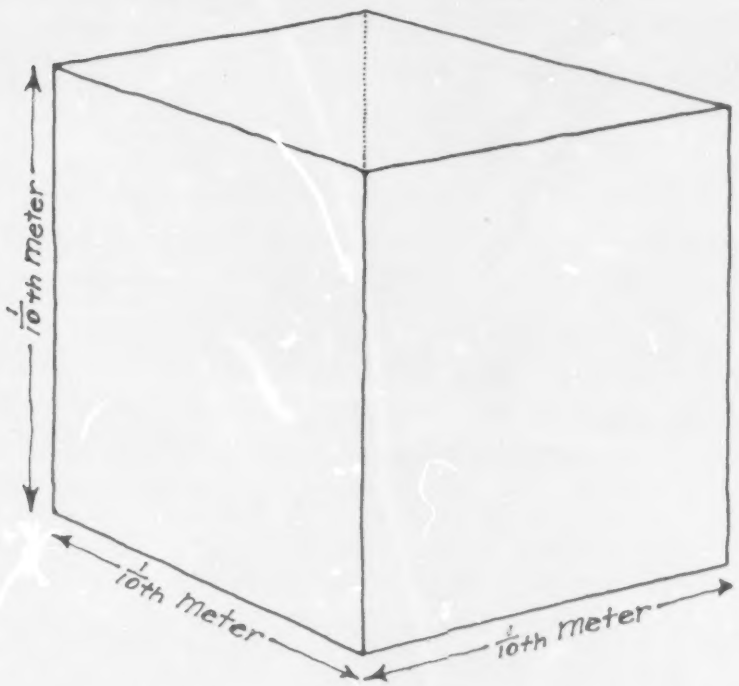


A similar hodge-podge of units was used in France at the time of the French Revolution. In 1789, the French Academy of Sciences was requested by the National Assembly to devise a new measurement system. The French Revolution was underway, and because of the antiaristocratic attitude of the French people, a change to a system not based on dimensions of royal monarchs was highly acceptable to them.

In developing the metric system the French scientists had three major objectives. The first objective was to find a unit of length that was measurable and reproducible everywhere, and natural in the physical world. To meet this objective, the meter was defined to be one ten-millionth of the distance from the equator to the north pole.

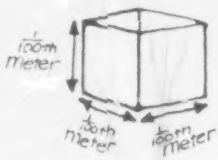


The second objective was to relate the unit of length to other units of measurement. For the main unit of capacity they selected a cube, with each of its sides equal to 1/10th of a meter (cubic decimeter), and called the amount of space contained within this box-shaped figure a "liter."



Liter

For the main unit of mass, the French scientists took a cube with each of its sides equal to 1/100th of a meter (a cubic centimeter), filled this box with pure water at 4° Centigrade, and designated the mass of this water as a "gram." Thus, the meter was used to define both the liter and gram.



Gram

The third objective was to simplify the conversion from one unit to another. We have already seen how a system of prefixes, which are powers of ten, was used to accomplish this objective. Since each metric unit is ten times larger than the next smaller unit, converting from one unit to another can be accomplished by merely moving a decimal point. Thus

35 meters = 0.035 kilometers
0.35 hectometers
3.5 dekameters
350 decimeters
3500 centimeters
35 000 millimeters

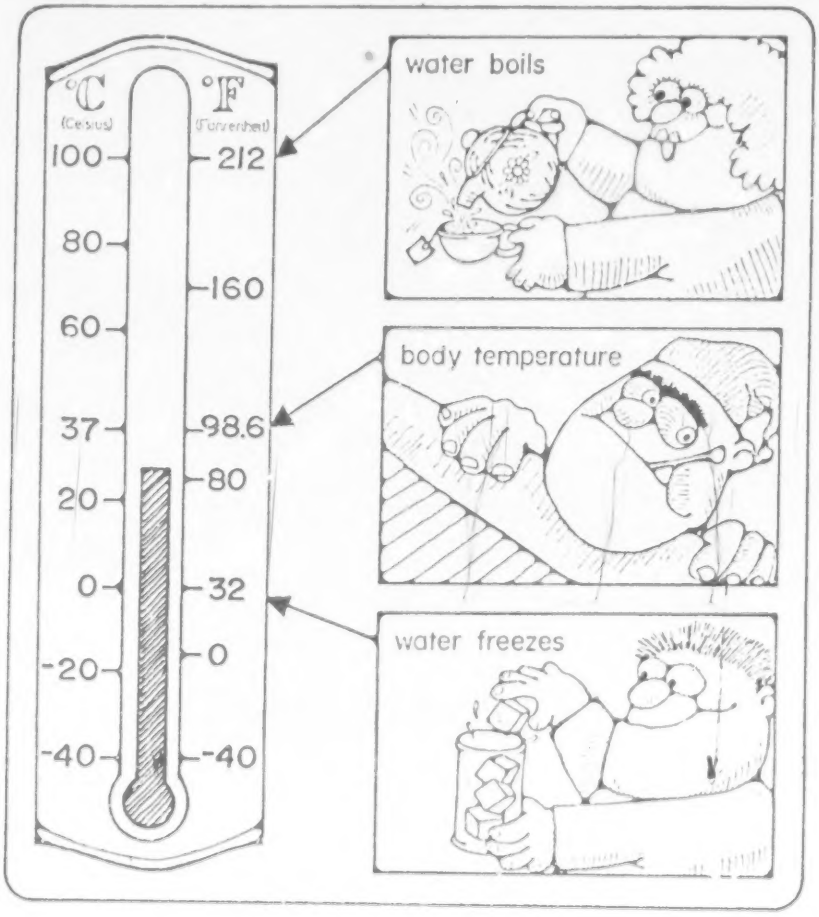
Scientists adopted the metric system immediately, for it made their work much simpler. Nations, on the other hand, have been slow to adopt it. It wasn't until 1840 that the French government made its use mandatory. By 1900, thirty-five nations had officially adopted it, and by the middle of this century, the main holdouts were the English-speaking nations. In 1965, England joined the European Common Market. Since Europe used the metric system, England decided to go metric. The other English-speaking nations soon followed. Ten years later, President Ford signed the Metric Conversion Act of 1975. Finally, after 180 years, the conversion to metric is nearing completion.

LESSON 5: TEMPERATURE

There is one more metric unit which is encountered in daily living, the unit for temperature, degree Celsius (pronounced sell-see-us). Most adults are surprised to learn that "degree Centigrade," which they vaguely remember from their school days, has been changed to "degree Celsius."

The change came about in 1948, at the General Conference on Weights and Measures which convenes periodically to review and ratify measurement standards. A debate arose concerning the name of a unit for metric temperature. Some conferees favored the English "degree Centigrade," and others favored the French "degré centisimal". By coincidence, the centigrade scale had been invented by Anders Celsius. Since his last name started with "C," his name was selected as a compromise.

The Celsius scale is simpler than the Fahrenheit scale. The drawing below illustrates its simplicity. Water boils at 100°C and freezes at 0°C. If you can remember the four temperatures shown on the thermometer, you'll have a good beginning on making sense of the Celsius scale.



LESSON 6: MASS (WEIGHT?)

The purpose of this lesson is to explain the difference between mass and weight. The kilogram is the unit of mass, and the Newton (after Sir Isaac Newton) is the unit of weight.

If you were an astronaut in outer space, the objects in your space craft would have very little weight. If you held a bowling ball in your hand and released it, it wouldn't fall. It would remain suspended in space. If the bowling ball were placed on a scale, it would read zero. It would be weightless. Why? Because the bowling ball is so far from the earth that it has escaped the pull of the earth's gravity.

Weight, then, is a measure of gravitational pull on an object. The weight of an object can vary, depending on where it is in the universe.

The mass of an object never varies. It is the same on earth as anywhere else in the universe. Mass is a measure of how much matter an object contains. The bowling ball is weightless in space, but it still has the same mass. Because of its mass, if you kicked it with your bare foot it would still hurt, whether you were on earth or in a spaceship.

We determine the weight of an object by spring scales which measure the downward pull on an object placed on it. This downward force is measured in Newtons. The mass of an object, on the other hand, is determined by using a balance: the object is placed on one side and balanced with standardized mass pieces. This is what a pharmacist does when he mixes a compound.

However, the mass of an object is directly proportional to its weight on earth. That is, a one-kilogram mass has a weight of about 9.8 Newtons at sea level; a two-kilogram mass has a weight of about 19.6 Newtons; etc. Thus, either mass or weight gives us a good measure of how much matter an object contains. Therefore, in everyday usage spring scales are used for determining mass in kilograms because it is much more convenient than using a balance. The 4M COMPANY uses the words interchangeably - mass (weight). For everyday usage, the distinction is unimportant.

LESSON 7: SI

The French scientists made several errors in their original calculations. For example, they miscalculated the distance from the equator to the north pole by about 2000 meters, and instead of being equal to one cubic decimeter, the liter was actually equal to 1.000028 cubic decimeters.

To correct these errors, various scientific organizations of the world met in 1960 to devise a modern metric system which is called the International System of Units (or SI for short, after the French Le Systéme Internationale d'Unités). SI was created to meet the exacting demands for precise scientific measurement. Most of the units and prefixes will not be used by the average citizen. But for the sake of completeness, we include a list of the base units and all the prefixes.

BASE UNITS

Quantity	Name	Symbol
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

Two units not on the list above are commonly used with the metric system. Instead of referring to liquid capacity in terms of cubic decimeters, the liter is used. And instead of using the Kelvin for temperature, degree Celsius is used (the Kelvin scale was derived from the Celsius scale).

PREFIXES

Prefix	Symbol	Pronunciation Symbol	Multiples & Fractions
exa	E	ex´ah	1 000 000 000 000 000 000
peta	P	pet´ah	1 000 000 000 000 000
tera	T	tear´ah	1 000 000 000 000
giga	G	jig´,ah	1 000 000 000
mega	M	meg´ah	1 000 000
kilo	k	kill´oh	1 000
hecto	h	heck´toh	100
deka	da	deck´ah	10
deci	d	dess´ih	0.1
centi	c	cent´ih	0.01
milli	m	mill´ih	0.001
micro	u	mike´roh	0.000 001
nano	n	nan´oh	0.000 000 001
pico	p	pee´koh	0.000 000 000 001
femto	f	fem´toh	0.000 000 000 000 001
atto	a	att´oh	0.000 000 000 000 000 001

Complete these equations if you can:

1 000 000 lomania = _____

1 000 000 000 ntic = _____

0.000 001 nesia = _____

1 000 000 000 000 tory = _____

0.000 000 000 000 000 001 rney = _____

1 000 000 000 000 000 000 rcist = _____

LESSON 8: SI STYLE CONVENTIONS

Think of it! There is no universal language, there is no universal monetary system. But at last we stand on the threshold of having a universal measurement system, a system understood by people all over the world. To make communication easier, certain style conventions are recommended. This section cites the major conventions.

1. Use a space to separate large numbers into groups of three. Do not use a comma. In many countries a comma is recognized as a decimal point.

Example:	Correct	Incorrect
	600 300.6	600,300.6

2. Use a zero in front of the decimal point when the numerical value is a partial unit.

Example:	Correct	Incorrect
	0.6 mm	.5 mm

3. Use a decimal to express partial units. Avoid using fractions to express partial units.

Example:	Correct	Incorrect
	0.25 kg	1/4 kg

4. Use uppercase or lowercase letters as they are given in the table. All abbreviations or symbols are to be used in the singular form. Do not use periods after symbols unless they conclude a sentence.

Example:	Correct	Incorrect
	mm (millimeters)	mms or mm's
	cg	c.g.
	ℓ	ℓ.

5. Prefixes must be combined with units. In common usage "kilo" means kilogram. Such usage is not preferred.

6. Avoid mixing units.

Example:	Correct	Incorrect
	12.75 m	12 m 75 cm

7. Avoid using multiple prefixes.

Example:	Correct	Incorrect
	ps (picosecond)	μμs (micromicrosecond)

8. Avoid capitalization of unit names (except Celsius) unless they start a sentence. Listings should be lowercase.

Example: Correct - The base unit for mass is the kilogram.

Incorrect - The base unit for mass is the Kilogram.

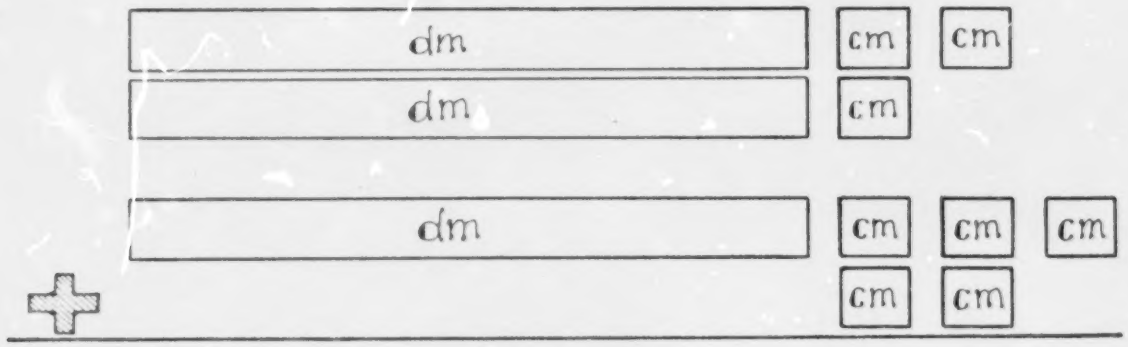
NEXT-TO-LAST-LESSON: DECIMALS

Our number system, our monetary system, and the metric system all share a common characteristic: they are decimal in nature. Because of this, the switch to metric makes the study of decimals even more important than ever. The 4M COMPANY begins the study of decimals in the third grade. The purpose of this lesson is to illustrate how the decimal nature of the metric system is used to teach decimals.

Since a decimeter is one-tenth of a meter, decimeters are used to introduce tenths. Students make a meter strip marked in tenths of meters and use it to measure various lengths.

Similarly, since a centimeter is one-hundredth of a meter, centimeters are used to introduce hundredths. And a millimeter, being one-thousandth of a meter, is used to introduce thousandths.

Addition and subtraction of decimals are explained in terms of metric units. Thus, the problem $\begin{array}{r} 0.23\ \text{m} \\ +0.15\ \text{m} \\ \hline \end{array}$ is represented as follows:



If placed end-to-end, these units would come to the 0.38 m mark on a meter marked in hundredths. Since 10 centimeters can be exchanged for 1 decimeter, borrowing and carrying are easily explained in terms of metric units. The students soon see that adding and subtracting decimals is very similar to adding and subtracting whole numbers.

LAST LESSON: METRIC FOR EVERYDAY LIVING

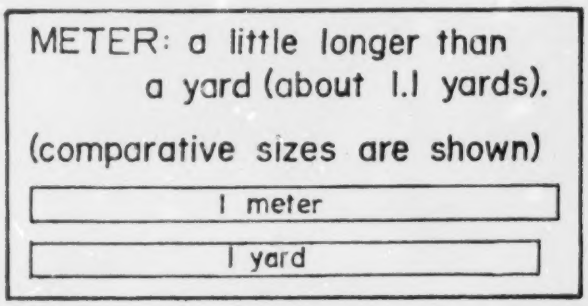
In this section we list those metric units which are most commonly used in everyday living.

Length: 1) A meter is a little longer than a yard.

2) A kilometer (1000 meters) is about 6/10th of a mile.

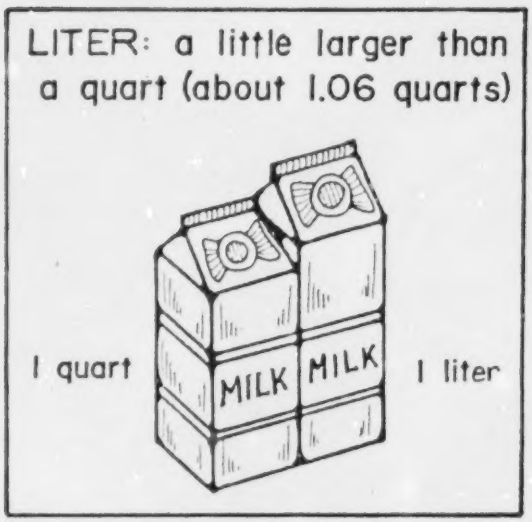
3) A centimeter (0.01 meter) is about the width of a paper clip.

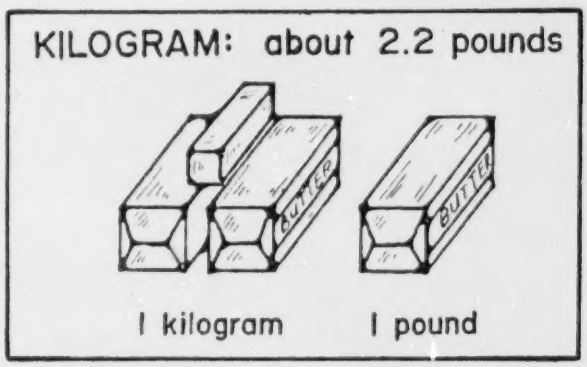
4) A millimeter (0.001 meter) is about the thickness of a dime.



Capacity: 1) A liter is a little larger than a quart (about 1.06 quarts).

2) A milliliter is 1/5th of a teaspoon.





Mass: 1) A gram is the mass of two small thumb tacks.

2) A kilogram is about 2.2 pounds.

3) A metric ton is 2200 pounds.

4) A milligram is the weight of a bee's wing.

ANSWERS TO PROBLEMS

LESSON 3:

hectogram	deciliter
dekaliter	centiliter
kilometer	decigram
milligram	dekagram
hectoliter	dekacards
centigram	deciArnaz
millimeter	centimentalist
centimeter	kilomanjaros
milliliter	millitary
hectoliter	decimate
kiloliter	kilowhats?
kilogram	milliscent
dekameter	centipede
decimeter	

LESSON 7:

megalomania
jigantic
micronesia
teratory
attorney
exarcist